

**Aeronautical  
Engineering  
A Continuing  
Bibliography  
with Indexes**

NASA SP-7037 (117)  
January 1980

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# AERONAUTICAL ENGINEERING

## A Continuing Bibliography

### Supplement 117

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in December 1979 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*.



Scientific and Technical Information Branch

1980

**National Aeronautics and Space Administration**

Washington, DC

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# INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 307 reports, journal articles, and other documents originally announced in December 1979 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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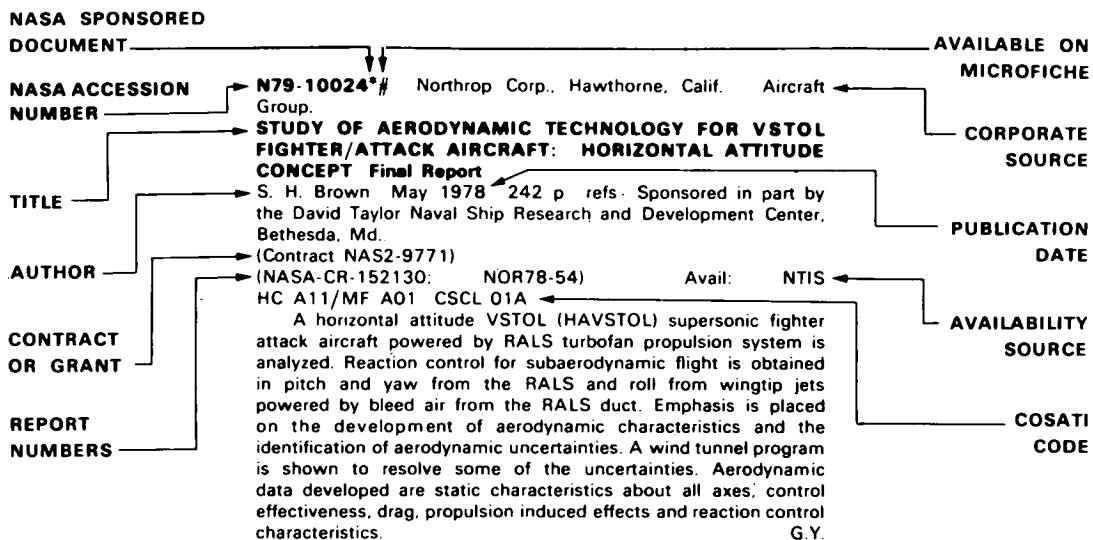
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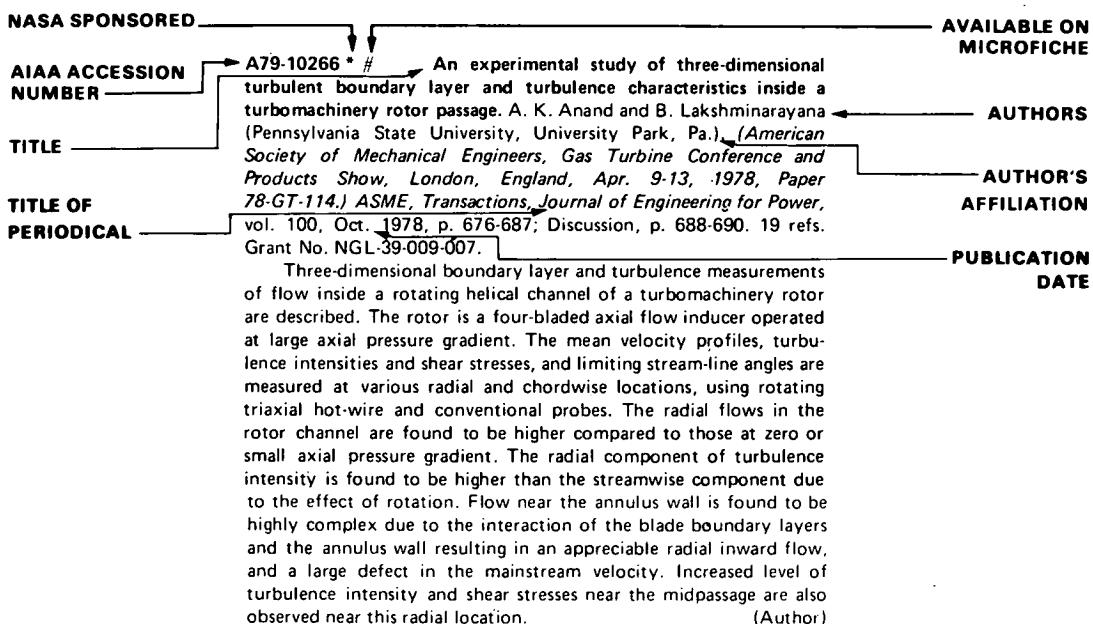
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## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 117)*

JANUARY 1980

## IAA ENTRIES

**A79-51048 #** The impact of low cost micro-processors on airborne navigation systems. P. A. Hearne and D. J. Hamlin (Marconi Avionics, Ltd., Rochester, Kent, England). *Journal of Navigation*, vol. 32, Sept. 1979, p. 375-390; Discussion, p. 390-394.

Until recently the classic digital computer with core store, arithmetic unit, microprogram logic, registers and input/output units still represented a substantial cost element, whose use could only be justified for relatively demanding tasks. The two factors which have now changed this are the use of semiconductor memories and the recent availability of low-cost microprocessors and bit-slice machines. The paper discusses the development of the cost-effective airborne computer, the definitions of important navigation system parameters, the attributes of an ideal navigator, the function/cost conflict, the ingredients of cost-effective navigation, the power of digital navigation, and new trends. The combination of dissimilar sensors in hybrid systems will usually offer better integrity and reversionary capability, and lower cost, than a multiplexed system of a single type of high-accuracy sensor.

S.D.

**A79-51049 #** Risk - Taken or controlled. P. H. Tanner (Glasgow, University, Glasgow, Scotland). *Journal of Navigation*, vol. 32, Sept. 1979, p. 395-414. 7 refs.

The practice of safety can be treated as the operation of a system with which it is intended to control the level of some parameter 'risk'. An attempt is made to describe the behavior of a population of individuals engaged in a risky occupation in terms of such a system. Casualty figures for commercial airline operations are analyzed to show that there is a *prima facie* case for a belief that in this case the risk level is regulated by those immediately engaged in the industry. A proposed 'input-output' model of an individual regulating his own risk is described, and preliminary results are given for a simulated population of aircraft operators. Finally, the credibility of the model in terms of known human behavior is examined, some tentative conclusions are drawn, and an indication is given of its proposed use and development.

S.D.

**A79-51090 \* #** A real-time simulation facility for advanced digital guidance and control system research. W. H. Bryant, D. R. Downing, and A. J. Ostroff (NASA, Langley Research Center, Flight Electronics Div., Hampton, Va.). *Institute of Electrical and Electronics Engineers and American Institute of Aeronautics and Astronautics, Digital Avionics Systems Conference, Fort Worth, Tex., Nov. 6-8, 1979, Paper*, 9 p. 7 refs.

A real-time simulation facility built at NASA's Langley Research Center to support digital guidance and control research and

development activities is examined. The unit has recently been used to develop autoland systems for VTOL. The paper describes the autoland experiment and the flight environment, the simulation facility hardware and software, and presents typical simulation data to illustrate the type of data analysis carried out during software development. Finally, flight data for a later version of the autoland system are presented to demonstrate the simulation's capability to predict overall system behavior.

M.E.P.

**A79-51091 \* #** Advanced crew station concepts, displays, and input/output technology for civil aircraft of the future. J. J. Hatfield, J. B. Robertson, and V. M. Batson (NASA, Langley Research Center, Hampton, Va.). *Institute of Electrical and Electronics Engineers and American Institute of Aeronautics and Astronautics, Digital Avionics Systems Conference, 3rd, Fort Worth, Tex., Nov. 6-8, 1979, Paper*, 11 p. 18 refs.

Current efforts on a new Cockpit Avionics Research program are described. The major thrusts of the program presented include: a comparative analysis of advanced display media and development of promising selected media, development of flight display generation techniques, and identification and development of promising I/O technology. In addition, the advanced integrated display concepts described include a 'tunnel in the sky' display and a traffic situation display with associated keyboard. Finally, the Cockpit Avionics Research program is summarized, future research plans are presented, and the need for an expanded program is discussed.

M.E.P.

**A79-51092 \* #** An evaluation of some display parameters for an advanced landing display. M. C. Waller, R. L. Harris, Sr., and S. Salmirs (NASA, Langley Research Center, Hampton, Va.). *National Technical Association, Annual Convention, 51st, Pittsburgh, Pa., Aug. 1-4, 1979, Paper*, 7 p.

This paper discusses the results of a series of tests conducted to better understand some of the design parameters related to presenting an aircraft landing display on a cathode ray tube (CRT). The study was conducted on an aircraft simulator and the results were evaluated in terms of touchdown performance, pilot control activity, and scanning behavior, that is, how the pilot used the display. The results of the study indicate that magnification, presentation of symbols representing aircraft state, and whether the display is presented in a conventional CRT head-down configuration or a collimated head-up configuration, all play a role in the pilot's performance.

(Author)

**A79-51093 \* #** Test technique development in interference free testing, flow visualization, and remote control model technology at Langley's Unitary Plan wind tunnel. W. A. Corlett (NASA, Langley Research Center, Hampton, Va.). *Supersonic Tunnel Association, Semi-Annual Meeting, 52nd, Notre Dame, Ind., Sept. 13, 14, 1979, Paper*, 18 p.

A metric half-span model is considered as a means of mechanical support for a wind-tunnel model which allows measurement of aerodynamic forces and moments without support interference or model distortion. This technique can be applied to interference-free propulsion models. The vapor screen method of flow visualization at supersonic Mach numbers is discussed. The use of smoke instead of water vapor as a medium to produce the screen is outlined. Vapor screen data are being used in the development of analytical vortex tracking programs. Test results for a remote control model system are evaluated. Detailed control effectiveness and cross-coupling data were obtained with a single run. For the afterbody tail configuration, tested control boundaries at several roll orientations were established utilizing the facility's on-line capability to 'fly' the model in the wind tunnel.

V.T.

**A79-51100 \*** # Comparison of alternate fuels for aircraft. R. D. Witcofski (NASA, Langley Research Center, Hampton, Va.), Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, International Symposium on Hydrogen in Air Transportation, Stuttgart, West Germany, Sept. 11-14, 1979, Paper. 37 p. 19 refs.

A comparison of candidate alternate fuels for aircraft is presented. The fuels discussed include liquid hydrogen, liquid methane, and synthetic aviation kerosene. Each fuel is evaluated from the standpoint of production, transmission, airport storage and distribution facilities, and use in aircraft. Technology deficient areas for cryogenic fuels, which should be advanced prior to the introduction of the fuels into the aviation industry, are identified, as are the cost and energy penalties associated with not achieving those advances. Environmental emissions and safety aspects of fuel selection are discussed. A detailed description of the various fuel production and liquefaction processes and their efficiencies and economics is given.

V.T.

**A79-51126** Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings (Conférence sur la Certification des Aéronefs contre les Dangers du Foudroiement et de l'Électricité Atmosphérique, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings). Conference supported by ONERA, U.S. Air Force, U.S. Navy, and NATO; Grant No. AF-AFOSR-78-3653. Châtillon-sous-Bagneux, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979. 221 p. In English and French.

The Conference focused on the theory of lightning phenomena, basic waveforms, lightning attachment and swept stroke testing, fuel vapor ignition and direct effects testing, indirect effects testing and lightning protection methodology, and static electricity. Specifically, papers were presented on laboratory tests to determine lightning attachment points with small aircraft, simulation of swept lightning strokes, laboratory tests to determine the possibility of ignition of fuel vapors by lightning, laboratory tests to determine the physical damage by lightning, test on actual aircraft for electromagnetic effects, direct effects protection methods for thin skins/composites, protection methods for hardware, static electricity phenomena and problems, fuel electrification, and aircraft testing.

A.T.

**A79-51128** # A new standard for lightning qualification testing of aircraft - Technical overview, definitions and basic waveforms. J. A. Plumer (Lightning Technologies, Inc., Pittsfield, Mass.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagneux, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 7-1 to 7-9; Discussion, p. 7-10. 13 refs.

The scope, lightning strike zone definitions, and test waveforms in the DOD draft standard 'Lightning Qualification Test Techniques for Aerospace Vehicles and Hardware' are summarized. Lightning attachment zones, direct and indirect lightning effects, and the lightning waveform parameters are defined, including the rate of rise voltage, the time to crest of a voltage waveform, the decay time, the charge transfer, and the action integral. The waveforms of the lightning voltages and currents to be simulated in the qualification tests are described in terms of voltage and current waveforms, and application of waveforms to qualification tests is discussed. A.T.

**A79-51129** # Laboratory tests to determine lightning attachment points with small aircraft models /engineering test/. P. F. Little (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagneux, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 8-1 to 8-9. 21 refs. Research supported by the Ministry of Defence (Procurement Executive) of England.

The simulation of lightning strikes to model aircraft involves an extrapolation from the behavior of laboratory sparks to fullscale lightning. This is not possible in detail, particularly since an isolated model is interposed into the two-electrode gap normally studied in the laboratory. This paper compares the attachment process to an aircraft with laboratory experiments, and discusses the influence of gap size, geometric scaling and voltage waveshape on the spread of attachment points. Particular emphasis is laid on the identification of low-probability attachment areas. A comparison with flight experience is the best test of the validity of any test technique, but no clear and complete agreement exists as to the best approach. Parameters and procedures that are generally acceptable are noted. (Author)

**A79-51130** # Laboratory tests to determine lightning attachment points with small aircraft models /engineering test/. D. W. Clifford (McDonnell Aircraft Engineering Laboratories, St. Louis, Mo.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagneux, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 9-1 to 9-3; Discussion, p. 9-4. 5 refs.

High voltage laboratory generators exist which are capable of producing long sparks up to several meters in length. These long sparks are often used in conjunction with scale model aircraft to predict the location of lightning attachment points on new aircraft designs. This paper discusses the equipment and procedures used to conduct model attachment point studies. It further evaluates the effects of certain testing variables on the results of the test. It will be seen that although uncertainties exist in the proper definition of some test parameters, adequate agreement has been observed between the results of laboratory tests and actual lightning strike histories of numerous aircraft to give confidence to the test. On that basis, a set of test parameters is defined for conducting engineering R&D tests on scale model aircraft for lightning attachment point determinations.

(Author)

**A79-51131** # Laboratory simulation of swept lightning strokes /Engineering test/. D. W. Clifford (McDonnell Aircraft Engineering Laboratories, St. Louis, Mo.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagneux, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagneux, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 10-1 to 10-8; Discussion, p. 10-9. 9 refs.

When an aircraft is struck by lightning in flight, the aircraft may fly through the stationary arc channel which often persists for large

fractions of a second. Consequently, the lightning attachment point appears to traverse the surface of the aircraft, carried by the windstream. This dynamic sweeping effect results in lightning attachment to surfaces of the aircraft which would not be struck directly. The nature of the sweeping action and the damage produced by a swept stroke can be simulated by testing. Various techniques have been employed, to either move the test surface through a stationary arc or to blow the ionized arc channel over the test surface. This paper describes the swept stroke phenomenon and important test parameters in swept stroke simulation. The importance of test article configuration, air flow, electrical current characteristics, and the behavior of high-current arcs is discussed.

(Author)

**A79-51132 # Laboratory simulation of swept lightning strokes.** P. F. Little (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 11-1 to 11-7; Discussion, p. 11-7. 7 refs. Research supported by the Ministry of Defence (Procurement Executive) of England.

Other methods of simulation of swept strokes than by the use of wind tunnels are described. The results of magnetically swept arc studies and rocket sled simulations are compared. Longer dwell times are observed with the rocket sled, and skip distance is not well correlated with dwell time. Arc instabilities appear to play a significant role in bridging the air gap between the arc and the specimen surface. A lower limit to the skip distance is set by the breakdown potential of the paint layer, if any. It is suggested that aircraft geometry and speed are not important in determining dwell times. The time between current surges in the lightning stroke should be considered as the upper limit for the dwell time. (Author)

**A79-51133 # Laboratory test procedures to determine lightning attachment points on actual aircraft parts (A qualification test).** J. A. Plumer (Lightning Technologies, Inc., Pittsfield, Mass.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 12-1 to 12-12. 5 refs.

Lightning flashes initially attach to aircraft extremities such as the nose, wing tips or vertical fin cap. If these extremities are covered with non-metallic skins such as fiberglass radomes, wing tips, or plastic antenna fairings, the lightning flash may puncture the skin and attach to a conductor within. Conductive diverters or other means may be necessary to protect against such punctures. Whether punctures occur or not depends upon the geometry of the structure and diverter arrangement (if present), the dielectric strength of the non-metallic skin, and the rate of rise of the electric field presented by the advancing leader. A test in which this electric field is simulated and applied to a full size replica of the structure in question may be utilized to determine the need for protection or verify its adequacy. This test is also utilized to identify lightning strike zone boundaries on metallic or advanced composite surfaces, and to determine whether windshields or canopies may be punctured by re-strikes occurring in swept lightning flashes. Typical high voltage test circuits, electrode arrangements and other considerations are described. (Author)

**A79-51134 # Laboratory tests to determine lightning attachment points on actual aircraft parts (Qualification test).** A. W. Hanson (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney,

Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 13-1 to 13-4. 5 refs. Research supported by the Ministry of Defence.

This paper proposes additional research in laboratory testing techniques for attachment point location on aircraft parts. The streamer formation within nonconducting structures is discussed; the experiment on the influence of the hardboard position on the gap breakdown voltage is described, noting that it was unexpected that the total system breakdown voltage could be in excess of the sum of the individual breakdown voltages, and additional work in this area is called for. Test methods for determining adequate electrode size, the effects of polarity and waveform, and the choice of the dV/dt for voltage waveform A are discussed, noting that streamers will proceed from the aircraft to meet the advancing leader, and the in-flight pressure distribution may have considerable effect on the development of streamers.

A.T.

**A79-51135 # Laboratory tests to determine the possibility of ignition of fuel vapors by lightning.** J. D. Robb (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 14-1 to 14-19, 14-20; Discussion, p. 14-19. 12 refs.

Of concern in new aircraft design is the possibility of fuel vapor ignition caused by lightning strikes. Lightning energies can enter the fuel tank vapor areas by sparking of joints and access doors, and by electric field coupling through plastic doors. The energies can be inductively or conductively coupled through fuel quantity probe wiring and can also cause ignition by hot spot heating of the fuel tank wall or by direct puncture of the skin. Tests have been devised to determine the adequacy of new fuel system designs and include (1) photographic viewing of tank interiors to check for sparking or streamerings, (2) use of confined flammability mixtures about the component being tested to check directly for possible ignition, (3) infra-red or thermocouple measurements of hot spot heating, and (4) voltage and current measurements of transients on wiring. Whereas some areas need further investigation, particularly with the new metal and composite materials being used for fuel tank skins, the fact that few aircraft losses have been caused by lightning ignition of aircraft fuel systems indicates that good confidence can be placed in the present test methods.

(Author)

**A79-51136 # Laboratory tests to determine the physical damage /direct effects/ caused by lightning /qualification test/.** A. W. Hanson (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 15-1 to 15-5. Research supported by the Ministry of Defence.

The paper describes the techniques that can be used to generate the test currents, conduct the tests, and to collect the experimental data for laboratory tests to determine the physical damage caused by lightning. Techniques for the simulation of the natural inflight strike environment, and the effects of arc length and other special factors are also discussed. Some guidance on instrumentation and diagnostics is also given.

(Author)

**A79-51137 # Laboratory tests to determine the physical damage /direct effects/ caused by lightning.** J. Skiba (Bundesministerium der Verteidigung, Bonn, West Germany). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 16-1 to 16-6; Discussion, p. 16-7.

This paper describes a lightning simulating facility, to determine physical damage, at the Technical University of Hannover, West Germany. The test facility simulates two phases of lightning, the first with a very high surge voltage and surge current load, and the second with a charge of several hundred coulombs. The generation of the initial lightning stroke by a bank of capacitors and other details of the electrical circuit are discussed, noting that a semicircular round tungsten 10 mm diameter rod is used as the electrode. Current measurement by a Rogowski coil and voltage/current recording equipment are described, and the appearance of sample damage illustrated. It was concluded that this facility can perform a wide range of simulation and also be used for the design of advanced composite structures. A.T.

**A79-51138 # Laboratory tests to simulate lightning streamers at apertures /A qualification test/.** J. A. Plumer (Lightning Technologies, Inc., Pittsfield, Mass.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 17-1 to 17-7.

When an aircraft becomes subjected to an electric field of sufficient intensity, corona and streamering may occur at locations where the electric field exceeds the corona inception level. Often these discharges occur at extremities where the radii of curvature is small, such as pitot probes, antennas, and wing, empennage or propeller tips; but they may also appear at discontinuities such as windshields or fuel vent outlets, or beneath dielectric covers. Since these discharges may have sufficient energy to ignite fuel vapors, it is frequently necessary to determine if they may occur within non-metallic fuel tanks and other enclosures that may contain such vapors. Streamers may also induce severe electrical transients in electrical circuits feeding windshield heaters or other exposed systems. A test in which the electric field that produces these streamers is applied to the aircraft has been included in the new standard. Methods of performing this test are described. (Author)

**A79-51139 # Laboratory tests for undesired conducted currents and surge voltages caused by lightning /Qualification test/.** D. W. Clifford (McDonnell Aircraft Engineering Laboratories, St. Louis, Mo.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 18-1 to 18-5.

This paper describes the equipment, current waveforms, and techniques for laboratory qualification tests of aircraft electrical equipment using high current generators to produce current pulses characteristic of natural lightning. The test objective is to measure voltages and currents produced on aircraft wiring when lightning attaches to externally-mounted hardware. The transient voltage coupling mechanisms, classified into arc attachment and induced coupling types; the test object, such as a probe or an antenna, and its installation to simulate its mounting on aircraft; and lightning high current and waveforms for modeling lightning strikes are discussed. Finally, the measurement equipment and techniques for intense electromagnetic fields in a wide range of frequencies are described. A.T.

**A79-51140 # Laboratory tests for undesired conducted currents and surge voltages caused by lightning /Qualification test/.** B. J. C. Burrows (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 19-1 to 19-4; Discussion p. 19-5. Research supported by the Ministry of Defence (Procurement Executive) of England.

The theoretical background for the extrapolation of induced voltages and currents measured during the test is described, and sample waveforms are shown. Guide lines are given for recognizing the appropriate coupling mechanism causing the induced voltage in order that the correct scaling may be applied. The choice of simulated impedances is discussed in consequence of the broad frequency spectrum of lightning pulses. (Author)

**A79-51141 # Tests on actual aircraft for electromagnetic effects /Engineering tests/.** B. J. C. Burrows (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 20-1 to 20-8; Discussion, p. 20-9. Research supported by the Ministry of Defence (Procurement Executive) of England.

The paper discusses the requirements for a ground test on an aircraft such that an adequate simulation of the in-flight lightning strike is achieved. However, lack of quantitative data prevents electric fields from being fully simulated. Both time-domain and frequency domain methods are discussed, and it is shown how driving point, earthing point, return conductor and capacitor bank design may be optimized for good simulation. In section II, the Culham quasi-coaxial system is described as applied to the Hawker Hunter test, and more recently to a composite forward fuselage test at General Dynamics. (Author)

**A79-51142 # Vulnerability assessment of aircraft systems to indirect lightning effects.** J. C. Corbin, Jr. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 21-1 to 21-16. 20 refs.

The important factors in a vulnerability assessment of aircraft systems to indirect lightning effects are considered. The characteristics of lightning, its dual hazard to aircraft systems, and its increasing hazard to electronic systems are discussed, and approaches to vulnerability assessment combining analysis, a test program, and hardening considerations are suggested. An electromagnetic coupling model, the lightning source term, the test requirements for indirect effects testing of a total vehicle, and a linear transient analysis based on these requirements are described. A low level, continuous wave swept frequency test and its application in verification of electromagnetic coupling models are noted. Finally, circuit and component testing are discussed, and an example of the approach to determine component susceptibility to lightning in a given electronic system is examined; facilities for evaluation of the vulnerability of an aircraft system are recommended. A.T.

**A79-51143 # Direct effects protection methods for thin skins/composites.** A. W. Hanson (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 22-1 to 22-3; Discussion, p. 22-4. Research supported by the Ministry of Defence.

The main increase in hazard from the direct effects of lightning currents resulting from the use of thin metal skins (i.e., less than 2mm thick) is mainly confined to the increased probability of arc root burn through. The technique of protection against this hazard by use of a thin ablating skin is discussed. With the use of carbon fibre composites, (Graphite/Epoxy composites), there is an increased hazard due to heat damage and delamination at all interfaces and joints. This can be reduced by careful design of the interface. At the arc attachment points greater energy input gives rise to more surface

damage than with aluminium alloy, and there is also a risk of severe delamination, although the risk of complete burn through is appreciably reduced. This damage can be avoided by the use of a thin metal protecting ablation layer. (Author)

**A79-51144 # Direct effects, protection methods for thin skins/composites.** J. Skiba (Bundesministerium der Verteidigung, Bonn, West Germany). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 23-1 to 23-10.

This paper describes the testing of protection methods for reinforced-fiber composites used in aircraft for their resistance to lightning strokes. The lightning damage to composite materials is greater than that of equivalent metal structures, requiring protective designs suitable for the material. The multilayer and the surface mesh systems using aluminum foil and mesh, flame-sprayed aluminum, and bronze mesh were used, together with heat curing synthetic resin CIBA 319 and cold-curing synthetic resin PR 340. The test procedure, including the electrode diameters and amperages, is specified, and it was shown that the composite systems protected by aluminum foil, flame-sprayed aluminum, and aluminum mesh provided the most lightning resistant design. A.T.

**A79-51145 # Protection methods for hardware.** J. A. Plumer (Lightning Technologies, Inc., Pittsfield, Mass.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 24-1 to 24-9; Discussion, p. 24-10, 22 refs.

This paper provides checklists of lightning protection methods for aircraft externally mounted components, nonmetallic structures, fuel system hardware, and control surfaces. The basic steps in the design of lightning protection, including determination of lightning strike zones and environments, vulnerable components, and protection criteria, are listed. Potential lightning problems in external hardware, such as air data probes, antennas, radomes, and windshields are discussed in a questionnaire form, with examples of common damage situations and their solutions. The fuel system checklist covers fuel tanks, access doors, drains, vents, and plumbing, and because of the catastrophic consequences of fuel ignition the questionnaire emphasizes the necessity for careful lightning protection. Finally, questions on flight controls, propellers, and nonmetallic aircraft are listed, concluding that the checklists and examples are intended as guidelines to help identify components which require lightning protection. A.T.

**A79-51146 # Protection/hardening of aircraft electronic systems against the indirect effects of lightning.** J. C. Corbin, Jr. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings.

Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 25-1 to 25-7; Discussion, p. 25-8, 9 refs.

Different approaches to protect or harden aircraft and their electronic systems against the indirect effects of lightning are examined. The basic approaches include (1) hardening the external structure to prevent the penetration of RF energy into the aircraft, (2) shielding equipment and cables, (3) hardening electronic circuits, and (4) combination of all three approaches. Approach (1) is advantageous since it uses the existing structure to protect a large number of electronic packages that would be expensive to modify to withstand large induced transients, and approach (2) was used in shielding electronic system elements in the B-1 aircraft against the nuclear electromagnetic pulse. Filtering, limiting, circuit design, and

functional hardening which can be used in approach (3) to harden electronic circuits to withstand transients that penetrate the external structure and shielded equipment bays were discussed. Finally, a systems approach was recommended for achieving an optimum hardened configuration. A.T.

**A79-51147 # Static electricity phenomena - Theory and problems.** J. E. Nanovicz (SRI International, Menlo Park, Calif.). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 26-1 to 26-14; Discussion, p. 26-14, 43 refs.

The charging mechanisms of static electrification of aircraft and the problems they cause are examined. Frictional, engine charging, and exogenous electrification is described, noting that these processes can produce damaging static electricity discharges and electrical noise. Frictional charging during flight through ice crystal clouds and helicopter charging and shock problems are considered. The effects of in-flight charging, including corona discharge characteristics, coupling of corona noise, dielectric surface discharges, discharges from windshields, and static charging caused by the firing of electro-explosive devices are discussed. Finally, deterioration of the dielectric surfaces and preventive measures are described. It is concluded that the charging processes cannot be eliminated, but their deleterious effects can be minimized by proper structural design.

A.T.

**A79-51148 # Fuel electrification.** A. W. Bright (Southampton University, Southampton, England). In: Conference on Certification of Aircraft for Lightning and Atmospheric Electricity Hazards, Châtillon-sous-Bagney, Hauts-de-Seine, France, September 14-21, 1978, Proceedings. Châtillon-sous-Bagney, Hauts-de-Seine, France, Office National d'Etudes et de Recherches Aérospatiales, 1979, p. 27-1 to 27-9, 13 refs.

Electrostatic charge generation and dissipation when low conductivity fuels flow in pipes and hazards of charged fuel flow into tanks are reviewed. The use of low conductivity plastics and composites for aircraft fuel tanks led to research in potential electrostatic hazards which included the use of charge collecting electrodes in plastic tanks and conducting polymers to complement the anti-static additives in the fuel. The basic electrostatic charge generation process and the high electric field safety criteria in metal and plastic fuel tanks are discussed. Discharge methods for elimination of static hazards, including active dischargers which deliver electrically neutral fuel to the tank, earthing plates, and conducting foams which can dissipate the charge are described. It was concluded that filter elements are the principal charging sources in fuelling systems, nonconducting materials increase the hazard level in fuel tanks, and fuel sloshing can produce high charge levels in plastic tanks.

A.T.

**A79-51241 A simple fluid-flow model of ground effect on hovering.** J. Lighthill. *Journal of Fluid Mechanics*, vol. 93, Aug. 29, 1979, p. 781-797, 12 refs.

Hovering motions, by which an animal (or a helicopter) in stationary fluid generates a downflow to support its weight, entail energy costs that include the induced power (power supplied to that downflow). The simplest classical model for induced power is the actuator-disk model. This paper shows how a relatively insignificant modification can be made to that model to make it aerodynamically self-consistent. The modified simple model of the downflow may be evaluated in fluid that either is unbounded or is bounded below by horizontal ground. Comparison of the calculated induced powers in the two cases (even though made in this paper not for the true axisymmetric flow patterns but for the corresponding two-dimensional flow patterns) appears to give a more satisfactory analysis than was previously available of the observed reduction of induced power associated with proximity to the ground. (Author)

**A79-51246 # Thrust vectoring applied to aircraft having high wing loading.** D. Bergman (General Dynamics Corp., Aerospace Technology Dept., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1812.* 10 p. 5 refs. Contract No. F33615-76-C-3106.

Aircraft designs having high ratios of weight-to-wing area (wing loading) are often outgrowths of missions biased toward low-level penetration and supersonic dash segments (primarily air-to-surface missions). Consequently, high-wing-loading aircraft often exhibit sharply diminished efficiency at high-g conditions when angle of attack exceeds normally low values, such as in missile avoidance maneuvers. One method for enhancing off-design, maneuver performance is to vector the engine thrust, which is an alternative to increasing the engine, wing, or tail/canard size. Also, thrust reversing (an extreme case of thrust vectoring) provides unique maneuvering capabilities as well as reduced landing distances. In this paper, an illustration is presented as to how thrust vectoring can be applied to a high-wing-loading airplane to enhance its performance. For an example aircraft configuration, powered, trimmed polars based on wind-tunnel test data are illustrative of performance improvements via proper scheduling of exhaust nozzle deflection. (Author)

**A79-51247 \* # Inlet design studies for a Mach 2.2 advanced supersonic cruise vehicle.** K. M. Shimabukuro, H. R. Welge, and A. C. Lee (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1814.* 11 p. 8 refs. Contract No. NAS1-14624.

Various inlet-engine combinations have been studied to find a preferred inlet concept for integration with an advanced technology Mach 2.2 cruise vehicle having a cruise lift-to-drag ratio of 9.6. For the purposes of this study, the range capability for a fixed takeoff gross weight was used to assess the various inlet-engine combinations. Inlet concept selection studies are described which indicated that an axisymmetric, mixed compression inlet was preferred. This study considered four inlet and three engine cycle combinations where the engine airflow was tailored to the inlet airflow delivery capability. Detailed design studies of two mixed compression inlet types are discussed. These were a translating centerbody inlet and a collapsing centerbody bicone inlet. The aerodynamic and mechanical design of each inlet is described. These inlets were also matched to different engine cycles tailored to the inlet airflow capability. The range increments favored the bicone inlet concept primarily because of lighter weight, reduced bleed air, and greater transonic airflow/thrust capability. (Author)

**A79-51248 # Experiences with an airborne digital computer system for general aviation flight testing.** R. J. Freuler, M. J. Hoffmann, and G. M. Gregorek (Ohio State University, Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1834.* 10 p. 7 refs.

A Digital Data Acquisition and Reduction System (DDARS) has been implemented for use in flight testing of general aviation aircraft. The DDARS package, assembled from off-the-shelf components selected for use in aircraft where minimum weight and low power requirements are of major concern, has demonstrated flexibility in application, reliability in performance, and a capability for in-flight data reduction. The features are due in part to the utilization of a full 16 bit microcomputer rather than an 8 bit microprocessor. Experiences with DDARS during flight testing of a single engine aircraft with a spanwise tailored wing and a twin engine business aircraft with surface pressure survey belts are presented. (Author)

**A79-51249 # Flight demonstration of the AV-8B V/STOL concept.** R. L. Bear, J. A. Hoef, and T. R. Lacey (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1841.* 9 p.

The predicted vertical and short takeoff performance and handling qualities of the YAV-8B aircraft were tested. In addition to the specific VTO and STO performance guarantees, another task of the YAV-8B flight test program is to investigate aircraft operation in the V/STOL modes of hover, vertical and short landing, and accelerating and decelerating transition, with regard to performance, aircraft handling, and pilot workload. Handling qualities results are presented for jetborne and semijetborne (longitudinal and lateral-directional) flights. The YAV-8B flight tests proved the predicted performance (doubling the payload-radius capability of the AV-8A) and flying quality improvements of the AV-8B concept. V.T.

**A79-51250 # The design impact of power-augmented ram technology on large energy efficient aircraft.** C. J. Martin and F. H. Krause (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1864.* 11 p. 17 refs.

The purpose of this paper is to present the energy saving advantages of power-augmented-ram (PAR) technology as applied to large aircraft. The increased efficiency in the areas of aerodynamic structures and propulsion are quantified. The requirements for the application of PAR to energy conservative aircraft flying in ground effect (WIG) or out of ground effect are presented. The design limitations and performance gains associated with PAR are identified. The PAR provides a substantial system performance improvement to aircraft designs flying either in or out of ground effect. Fuel efficient PAR-WIG vehicles, compared to conventional land based aircraft, are capable of three times the payload delivered for a pound of fuel used. (Author)

**A79-51266 # Construction of electronic models of microwave landing systems (O postroenii elektronnoi modeli mikrovolnovoi sistemy posadki samoletov).** A. I. Nikitin. *Radiotekhnika*, vol. 34, June 1979, p. 39-41. 5 refs. In Russian.

A algorithm is presented for the electronic simulation of microwave landing systems. The method involves simulation of MLS signals on the second intermediate frequency of the onboard receiver. The proposed model makes it possible to evaluate the accuracy and noise immunity of microwave landing systems. B.J.

**A79-51347 # Contribution to the asymptotic theory of sonic flow past airfoil profiles (K asimptoticheskoi teorii obtekaniia profilja zvukovym potokom).** A. L. Brezhnev and I. A. Chernov. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, May-June 1979, p. 99-107. 13 refs. In Russian.

For gas flows past airfoil profiles at speeds equal to the speed of sound at infinity, Frankl (1951) has shown that the principal term of the respective asymptotic expansion constitutes a similar solution of the Tricomi equation to which the problem reduces in the first approximation. In the present paper, solutions of the Tricomi equation are obtained which describe the asymptotic flow in the farfield of an arbitrary airfoil profile at a sonic velocity at infinity. Three asymptotic type solutions for nozzle flows are used as the higher approximations to Frankl's solution. V.P.

**A79-51451 # A CO2 laser for a compact imaging radar.** S. Marcus and J. W. Caunt (MIT, Lexington, Mass.). In: *International Conference on Lasers, Orlando, Fla., December 11-15, 1978, Proceedings.* McLean, Va., STS Press, 1979, p. 464-468. USAF-sponsored research.

A compact CO<sub>2</sub> laser has been developed for field use as part of an infrared heterodyne imaging radar. The laser, which contains a separate local oscillator, transmits 10 watts CW and can be electro-optically Q-switched at 100 kHz. (Author)

**A79-51464 # Coherent optical processing for missile guidance.** G. Calderone, A. Reich, J. Connelly, and M. Ginsberg (Grumman Aerospace Corp., Bethpage, N.Y.). In: *International*

Conference on Lasers, Orlando, Fla., December 11-15, 1978, Proceedings. McLean, Va., STS Press, 1979, p. 595-601.

The paper describes a coherent optical processing technology called optical matched filter area correlation, for difficult problems in real-time recognition and tracking of signals and targets. The methods involve development of a terminal guidance correlator for future missile air frames. The self-contained system features a high capacity optical memory which enables it to perform rapid updates and provide recognition and track error signals. The system employs a holographic lens matrix and a brassboard matrix in a 10-by-10 format as well as a propriety unit referred to as a real-time transducer.

C.F.W.

**A79-51598 # Impact of noise generated by supersonic transports on the environment (Shum, sozdavaemyi svrkhzvukovymi transportnymi samoletami na mestnosti).** E. M. Zhmulin, A. G. Munin, A. A. Tupolev, and G. A. Cheremukhin. *Akusticheskii Zhurnal*, vol. 25, July-Aug. 1979, p. 521-527. In Russian.

In the present paper, the noise characteristics of the Tu-144 and the Concorde are analyzed, and noise abatement methods are examined. The noise characteristics of supersonic and subsonic aircraft are compared. The expected noise levels of second-generation SSTs are assessed, and some suggestions concerning SST noise regulations are proposed.

V.P.

**A79-51684 # A method for calculating the potential flow around a system of aerodynamic profiles in an incompressible fluid (Metod rascheta potentsial'nogo obtekaniia sistemy aerodinamicheskikh profilei v neszhimaemoi zhidkosti).** A. A. Zaitsev and A. M. Komarov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR). *Moskovskii Universitet, Vestnik, Seria I - Matematika, Mekhanika*, May-June 1979, p. 65-69. 7 refs. In Russian.

A method for computing the potential flow of an ideal incompressible fluid around a set of aerodynamic profiles of a slit wing is presented. The system of Fredholm integral equations for the intensity of the vortex layer is reduced to a set of linear algebraic equations which are solved in successive iteration for each profile. The computation is illustrated for a single profile, and its application in a computer program to calculate the potential flow around a wing/trailing-edge flap system is shown to agree with the results obtained in the exact solution.

A.L.W.

**A79-51704 # Structural design and analysis of prop-fan blades.** R. W. Cornell and E. A. Rothman (United Technologies Corp., Windsor Locks, Conn.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1116*. 13 p. 17 refs.

As part of the NASA Aircraft Energy Efficient program, Prop-Fan equipped aircraft have been identified for reducing fuel consumption by 20 to 40 percent at 0.7-0.8 Mach Number (Mn) when compared to aircraft equipped with high bypass turbofan engines of equivalent technology. This fuel saving is attributable to the aerodynamic performance of the Prop-Fan propulsion system which results largely from the geometric shape of the blade. The lightweight blade construction concept pioneered by Hamilton Standard is reviewed and the resulting features of high stiffness, strength, and service induced damage tolerance are shown to apply readily to the Prop-Fan blade. The structural analysis of the blade by finite element methods is covered. The resulting characteristics of untwist, steady and vibratory stressing, frequencies and mode shapes are discussed and compared with appropriate criteria to provide a complete view of the dynamic response, life, FOD resistance, and stability of the blade in its operating environment.

(Author)

**A79-51705 # An advanced technology engine family for general aviation.** J. L. Nye (General Electric Co., West Lynn, Mass.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1161*. 6 p.

The design features of the GE advanced technology CT7 turboshaft engine, a civilian derivative of the U.S. Army T700, are surveyed. The engine is the result of a development program which included studies of various configuration alternatives early in the design cycle. It is shown how the engine's features reduce operating costs. These include reduced specific fuel consumption and weight, high reliability, simplified maintenance and improved cost/benefit ratio. The engine features 97% commonality with the T700 and is made up of four major components, an accessory module, a cold-section/compressor module, a hot-section/turbine module, and a power turbine module. Performance improvements are covered and derivatives such as a turboprop and a turbofan are noted.

M.E.P.

**A79-51707 # Nozzle design and integration in an advanced supersonic fighter.** E. H. Miller, J. Protopapas (Grumman Aerospace Corp., Bethpage, N.Y.), R. Obye (United Technologies Corp., East Hartford, Conn.), and W. Wooten (General Electric Co., Fairfield, Conn.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1813*. 11 p. 21 refs.

Numerous studies aimed at evaluating the key advances in vehicle design have highlighted the importance of propulsion integration in the aircraft. This paper describes the design and integration of advanced nozzles in a future supersonic fighter. The requirements for such a nozzle include operation at high area ratio during supersonic cruise, vectoring for STOL field performance and maneuvering, use of thrust reversers for combat and basing, good airframe integration, and high thrust performance with minimal thrust cooling losses. Such a nozzle configuration must also have favorable stealth characteristics in providing a low IR and RCS signature. The advanced nozzles, their mechanisms, and their performance are described. Takeoff gross weight studies were performed, and thrust reverser and vectoring performance were analyzed in terms of takeoff and landing distances. The effects of thrust vectoring on maneuverability were also examined.

(Author)

**A79-51912 # VSCF aircraft electrical power.** H. G. Carlson and R. N. Wright (General Electric Co., Aircraft Equipment Div., Binghamton, N.Y.). In: *Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings, Volume 2*. Washington, D.C., American Chemical Society, 1979, p. 1310-1317. 5 refs.

(Author)

**A79-51913 # Frequency converter technology for aircraft power systems.** W. McMurray (General Electric Co., Schenectady, N.Y.). In: *Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings, Volume 2*. Washington, D.C., American Chemical Society, 1979, p. 1318-1323. 8 refs.

The paper presents a general overview of the basic converter technology in qualitative terms, with the objective of conveying insight into the rationale for the selection of particular power circuit arrangements. The tradeoffs involved in the design process are discussed with respect to the factors involving size and performance. Attention is given to phase controlled converters and cyclo-converters, and the limitations involved in their use, due to varying I/O frequencies. Two methods are discussed that improve the output waveform in the inverter circuit, including the multiple pulsewidth modulation (PWM) or 'subharmonic' control. The adjustment and regulation of the ac output voltage of an inverter is examined and four methods are cited, as well as showing the comparisons made between cyclo-converters and inverters.

C.F.W.

**A79-51914** AC aircraft electrical systems with rare earth permanent magnet machines. D. L. Lafuze (General Electric Co., Aircraft Electrical Equipment Div., Binghamton, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings. Volume 2.

Washington, D.C., American Chemical Society, 1979, p. 1324-1330. 7 refs. USAF-sponsored research.

A summary of the results taken from two programs for large power systems, employing rare earth samarian cobalt permanent magnets is presented. One type 150 KVA starter/VCSF was built and tested in the first program while the second, consisting of eleven 60 KVA starter generators for flight tests is not yet completed. The system operation is discussed with emphasis on generate mode and start mode operation, as well as the impact of the characteristics of the PM machine. It was determined that the use of rare earth samarian cobalt magnets will provide air gap flux densities equal to those of electrically excited machines and therefore equal their performance. Permanent, loss free, excitation was found to provide the 400 Hz powered PM machine with efficiency and due to its simple rotor design, a new standard of reliability is made possible.

C.F.W.

**A79-51915** Results of power systems study advanced fighter/attack and V/STOL airplanes. J. A. Rhoden, P. R. Wood (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.), and O. Jethon (U.S. Naval Air Propulsion Test Center, Trenton, N.J.). In: Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings. Volume 2. Washington, D.C., American Chemical Society, 1979, p. 1331-1335. Contract No. N00140-76-C-0206.

A study program was conducted to identify the payoffs of a self-sufficiency using an on-board gas turbine auxiliary power unit. A broad spectrum of advanced aircraft were studied including V/STOL and conventional configurations. Candidate systems studied are reviewed as well as conclusions on optimum system configurations. Projected advanced technology improvements are also discussed for auxiliary power units.

(Author)

**A79-51916 #** USAF thrust in aircraft electrical power technology. D. G. Fox (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings. Volume 2. Washington, D.C., American Chemical Society, 1979, p. 1336-1340.

The paper presents the thrust of the Air Force Aero Propulsion Laboratory's development program on future aircraft electrical power systems to provide high reliability and improved power quality over existing operational systems. Attention is given to the improvements made in power distribution using a control computer interfaced by a multiplexed data bus with remote terminals. It is shown that the electrical power system performance can be improved by applying advanced generators and solid state switching and control. The use of common equipment can be advanced on small aircraft by integrating the power control subsystem with a multiplexed digital avionics information system.

C.F.W.

**A79-51917** Lightweight hydraulic systems development. J. N. Demarchi (Rockwell International Corp., Columbus Aircraft Div., Columbus, Ohio) and J. Ohlson (U.S. Naval National Command, Naval Air Development Center, Warminster, Pa.). In: Intersociety Energy Conversion Engineering Conference, 14th, Boston, Mass., August 5-10, 1979, Proceedings. Volume 2. Washington, D.C., American Chemical Society, 1979, p. 1341-1345. 6 refs. Navy-supported research.

The paper discusses the development of aircraft lightweight hydraulic systems which utilize high operating pressure, 8000 psi, as compared to today's 3000 psi systems. The concept of utilizing higher operating pressures for aircraft hydraulic systems provides for significant reductions in both weight and volume. The power level of hydraulic systems in military aircraft has risen from less than 10 horsepower in the early 1940's to nearly 300 on the Navy's modern

F-14 fighter, 500 on the SST Concorde, and 1000 on the Air Force's B-1 bomber. A selection of 8000 psi was determined to be the best practical level to operate an aircraft hydraulic system and this pressure level was applied to the Navy's F-14. It was theoretically determined that 30% of the weight and 40% of the volume of the F-14 hydraulic system could be reduced. In order to verify the overall concept, a short flight test program was conducted in the Rockwell/Navy T-2C basic trainer aircraft.

(Author)

**A79-52046 \*** Pulsed laser Doppler measurements of wind shear. C. DiMarzio, C. Harris (Raytheon Co., Wayland, Mass.), J. W. Bilbro, E. A. Weaver (NASA, Marshall Space Flight Center, Huntsville, Ala.), D. C. Burnham, and J. N. Hallock (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). *American Meteorological Society, Bulletin*, vol. 60, Sept. 1979, p. 1061-1066.

There is a need for a sensor at the airport that can remotely detect, identify, and track wind shears near the airport in order to assure aircraft safety. To determine the viability of a laser wind-shear system, the NASA pulsed coherent Doppler CO2 lidar (Jelalian et al., 1972) was installed in a semitrailer van with a rooftop-mounted hemispherical scanner and was used to monitor thunderstorm gust fronts. Wind shears associated with the gust fronts at the Kennedy Space Center (KSC) between 5 July and 4 August 1978 were measured and tracked. The most significant data collected at KSC are discussed. The wind shears were clearly visible in both real-time velocity vs. azimuth plots and in postprocessing displays of velocities vs. position. The results indicate that a lidar system cannot be used effectively when moderate precipitation exists between the sensor and the region of interest.

S.D.

**A79-52128 #** Influence of the ellipticity of the inlet section of an S-shaped air intake on the uniformity of the outward flow (Vliianie elliptichnosti vkhodnogo secheniya S-obraznogo vozdukhozabornika na ravnomernost' vykhodiaschego potoka). A. A. Badiagin. *Aviatsionnaya Tekhnika*, no. 2, 1979, p. 12-15. In Russian.

The present analysis deals with the results of an aerodynamic experiment carried out with three versions of a subsonic air intake with an S-shaped center line, differing in the degree of ellipticity of the inlet section. An air intake with an elliptic inlet section is found to provide the most uniform flow.

V.P.

**A79-52129 #** Approximation of the aerodynamic characteristics of a wing with a double-slotted flap (Ob approksimatsii aerodinamicheskikh kharakteristik kryla s dvukhvezvennym zakrylkom). A. K. Vatolin, V. A. Ovchinnikov, V. G. Pavlov, and E. Ia. Fedorov. *Aviatsionnaya Tekhnika*, no. 2, 1979, p. 16-21. 6 refs. In Russian.

The present analysis deals with the problem of approximating the aerodynamic characteristics of a wing with double-slotted flap by the method of least squares. It is shown that satisfactory approximation can be achieved by expressing the aerodynamic characteristics in the form of a quadratic polynomial. A set of wing parameters, optimal with respect to lift, is derived.

V.P.

**A79-52130 #** Preparation of double-curvature planking by rolling (Izgotovlenie obshivok dvoinoi krivizny raskatkoj). V. I. Ershov, M. A. Markeev, and V. A. Zakharov. *Aviatsionnaya Tekhnika*, no. 2, 1979, p. 22-26. In Russian.

In the present work, the shaping mechanism in the preparation of double-curvature planking by line-to-line rolling is identified, using 0.5 to 1.5 mm D16AT and AlMg6N sheet. The influence of a variety of factors on the rolling process is determined from the results of a factor experiment. It is shown that line-by-line rolling makes it possible to obtain double-curvature components of practically unlimited length, whose surface roughness depends only on the purity and smoothness of the working surfaces.

V.P.

**A79-52138 # Aircraft takeoff from a ski-jump platform (Vzlet samoleta s tramplina).** L. P. Fedorov. *Aviatsionnaia Tekhnika*, no. 2, 1979, p. 70-76. In Russian.

The present analysis deals with the principle of using a curved ramp ('ski jump') for launching jet V/STOL aircraft from the bow of a ship. The optimum ballistic trajectory on the upward and downward paths, which ensures the lowest take-off speed is calculated. An approximate formula for the take-off speed is derived, along with formulas defining the dimensions of the ski jump and the motion along the jump. V.P.

**A79-52144 # Determination of the probability of consequences of aircraft-system malfunctions in the evaluation of flight safety levels (K opredeleniiu veroiatnosti posledstvii otkazov samoletnykh sistem pri otsenke urovnia bezopasnosti poletov).** G. N. Kotel'nikov. *Aviatsionnaia Tekhnika*, no. 2, 1979, p. 102-106. In Russian.

Under flight conditions, the pilot has to cope with the consequences of subsystem and element malfunctions rather than with the malfunctions themselves. In the present paper, a method is proposed for calculating the probability of malfunction consequences in the context of determining flight safety levels based on the reliability of aircraft systems. V.P.

**A79-52145 # Flexibility of the bearing pedestals of control-surface hinge plates (O podatlivosti kronshteinov naveski rulei).** V. A. Pavlov. *Aviatsionnaia Tekhnika*, no. 2, 1979, p. 106-109. 6 refs. In Russian.

The bearing pedestals of hinge plates of tail control surfaces are conventionally designed under the assumption that they are not subjected to bending forces in their own plane. In the present paper it is shown that this is true only in the case of tension, whereas under actual conditions the bearing pedestals may experience compression. A procedure for calculating the flexibility of bearing pedestals for compression is proposed. V.P.

**A79-52146 # Stability of the perturbed longitudinal motion of a lift-controlled aircraft (Ob ustoichivosti prodol'nogo vozmu-shchennogo dvizheniiia samoleta s sistemoi upravleniia pod'emnoi siloi).** V. I. Pentiukov. *Aviatsionnaia Tekhnika*, no. 2, 1979, p. 110-112. In Russian.

It has been shown that the addition of supplementary wing surfaces to the system of longitudinal control makes it possible to control lift, thereby improving control efficiency under conditions of turbulence. The effectiveness of control in the presence of turbulence depends to a great degree on the parameters of the supplementary surfaces. In the present paper, the influence of the aerodynamic characteristics of the supplementary control surfaces on the dynamic stability of the aircraft is analyzed. V.P.

**A79-52147 # Calculation of the pressure distribution over a slender wing in supersonic flow (Raschet raspredeleniiia davleniiia po tonkim kryl'iam v svarkhzhukovom potoke).** V. I. Sergeev. *Aviatsionnaia Tekhnika*, no. 2, 1979, p. 112-119. 8 refs. In Russian.

A method is proposed for calculating the pressure distribution over slender wings with the straight and curved subsonic leading edges in supersonic flight. The method is based on the theory of conical and quasi-conical flow. A BESM-6 computer program for calculating the pressure distribution over delta wings for various deformation laws is proposed. V.P.

**A79-52268 Synthesis of the thickness effect in the case of flow past a slender delta wing with leading edge vortices.** A. K. Ray and S. Sharma (Ottawa, University, Ottawa, Canada). *Acta Mechanica*, vol. 33, no. 1-2, 1979, p. 69-80. 11 refs.

By successive conformal transformations, the flow past a semicircular cone has been investigated with the help of Mangler and Smith's mathematical model of the flow past a slender delta wing with zero thickness. The thickness effect has thus been directly determined in the case of flow past slender delta wing and the lift

and drag coefficients have been calculated in terms of dimensionless angle of incidence. Further, the lift coefficient has been compared with the semi-empirical result of Bergsen and Porter. (Author)

**A79-52273 The effect of short regions of high surface curvature on turbulent boundary layers.** A. J. Smits, S. T. B. Young, and P. Bradshaw (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics*, vol. 94, Sept. 25, 1979, p. 209-242. 30 refs. Research supported by the Ministry of Defence (Procurement Executive).

The paper presents measurements made in low-speed turbulent boundary layers on flat surfaces downstream of concave or convex bends with turning angles of 20 or 30 degrees. It is noted that these short bends approximate to 'impulses' of curvature, and that the object of the work is to investigate the impulse response of the boundary layer, especially the decay of structural changes downstream of the bends. It is reported that the most striking feature of the 'impulse' response is that the decay of the high turbulent intensity found at exit from the concave bends is not monotonic. Further, it is found that on the convex side the flow recovers, monotonically in the main, from a low level of turbulent intensity at the exit. Finally, it is noted that strong spanwise variations, due presumably to longitudinal vortices, further complicate the flow in the concave bends, and decay only very slowly downstream. M.E.P.

**A79-52300 Airport plan based on the PIPE concept proposal for a remodelled Catania-Fontanarossa.** B. U. Petit. *Airport Forum*, vol. 9, Aug. 1979, p. 119-123. In English and German.

A proposal for expanding the facilities of the Sicilian, Catania-Fontanarossa airport is presented. It includes an extension of the runway from 2350 to 2600 m, construction of a taxiway and turnoff at the south end of the runway, extension of the apron, construction of a new passenger terminal, a cargo terminal to handle 17,000 tons a year, a new control tower, and a provision for security equipment. A two-phase project for 1980 to 1985 is discussed that will extend the passenger capacity to 1.8 million per year, through the first phase, and will double by the end of phase two. A description of the project, which is related to the PIPE project is given, emphasizing the physical layout of the terminal building. C.F.W.

**A79-52349 Windshear indication systems.** B. Rek. *Flight International*, vol. 116, Sept. 22, 1979, p. 984-986.

The present paper deals with three windshear indicator versions developed by Smiths in the United Kingdom, Sfena in France, and Safe Flight Instrument Corporation in the United States. The UK and French versions are combined with a VSI, whereas the U.S. version is devised as a separate instrument. The U.K. version is a modified VSI which uses an extra pointer to convey windshear information, presented as aircraft energy rate. Sfena's windshear indicator also is combined with a VSI, but features two dots, instead of a pointer, which move around the height-rate scale's circumference. In addition, it includes a digital angle-of-attack readout. The U.S. version is driven by a windshear computer (weighing six pounds) which drives the horizontal shear component by subtracting ASI information from accelerometer data. The vertical component is derived from another accelerometer whose signal is divided by airspeed to obtain downdrift drift angle (in radians). The conceptual difference is that the foreign instruments tell the pilot 'what the aircraft is doing' while the U.S. version displays 'what the wind is doing'.

V.P.

**A79-52350 Fundamentals of design. IV - Weapon carriage and delivery.** B. R. A. Burns. *Air International*, vol. 17, Oct. 1979, p. 176-180, 181-185, 196.

The problem of impaired aircraft performance due to the addition of external weapons is discussed. It is noted that cost is the prime reason why such modifications are made, since most ground attack aircraft were originally intended as fighters. The dual role capability is frequently added to facilitate export sales to smaller

countries which cannot afford specialized types. Attention is given to the primary considerations affecting weapon carriage design: low drag, high delivery accuracy, minimum disturbance to engines, absence of flutter, acceptable effects on stability, and accessibility. It is concluded that on future combat aircraft such factors will be designed in from the start so that performance and operational penalties will be smaller than in the past.

M.E.P.

**A79-52438** Effect of cooling of the central body on startup, separation of the flow at the intake and the throttling characteristics of air scoops at supersonic and hypersonic velocities. V. G. Gurylev and Iu. A. Mamet'ev. (*TsAGI, Uchenye Zapiski*, vol. 6, no. 2, 1975, p. 139-146.) *Fluid Mechanics - Soviet Research*, vol. 7, May-June 1978, p. 158-167. 7 refs. Translation.

Experimental data are presented concerning the effects of cooling the surface of the central section of an air intake on intake parameters for the free stream Mach number range of 2.5-9.7 and the Reynolds number (determined from inlet and length parameters) range of 10 to the 6th to 10 to the 8th in turbulent and laminar boundary layers. It is shown that for a turbulent boundary layer at the inlet in the M range of 2.5-5.5, the effect of cooling on start-up, flow separation and throttling characteristics is small, while for the laminar boundary layer ( $M = 5-9.7$ ), the cooling of the central section ensures unseparated flow before the inlet and considerably improves the throttling characteristics of the intake.

B.J.

**A79-52445** Interference of vortices with shocks in air-scoops - Dissipation of vortices. V. V. Zatoloka, A. K. Ivaniushkin, and A. V. Nikolaev (Tsentrall'nyi Aerogidrodinamicheskii Institut, Moscow, USSR). (*TsAGI, Uchenye Zapiski*, vol. 6, no. 2, 1975, p. 134-138.) *Fluid Mechanics - Soviet Research*, vol. 7, July-Aug. 1978, p. 153-158. Translation.

The paper gives a theoretical description and presents experimental results on the destruction of a vortex street in a supersonic air intake due to interference with an intense shock front. It is shown that a dead zone with a conical shock wave is formed in the free flow. Flow parameters in the separated region are roughly the same as those in turbulent boundary layer separation. It is found that vortex-shock interference can sometimes worsen the efficiency of a supersonic intake.

B.J.

**A79-52482** # Rotation of a loaded rotor in a rigid bearing (Ob obkate nagruzhevnogo rotora po zhestkому podshipniku). V. M. Sandalov and Iu. V. Tsvetkov. *Akademii Nauk SSSR, Izvestiya, Mekhanika Tverdogo Tela*, May-June 1979, p. 52-56. In Russian.

The analysis deals with the interaction between a balanced rotor loaded by a constant force and an absolutely rigid bearing, in the case of plane-parallel displacements of the rotor and a constant spinning rate. It is shown that, contrary to the case of an unloaded rotor, loading by a constant force leads to a symmetry breakdown of the problem and, as a consequence, to an increase in the dimensionality of the phase space of the dynamic system composed of the rotor and the bearing.

V.P.

**A79-52500** # The thermal oxidation stability of B-3V lubricant (Termookisitel'naya stabil'nost' masti B-3V). V. G. Kuznetsov, G. T. Novosartov, S. S. Al'tman, and A. A. Myshalova. *Khimiia i Tekhnologiya Topliv i Maset*, no. 9, 1979, p. 48-50. 5 refs. In Russian.

Means for increasing the thermal oxidation stability of aviation lubricant B-3V are investigated. Measurements of deposit formation and oxidation temperature reveal that the newly developed lubricant VNII NP-75a, with a pentaerythrite ether base, is significantly more resistant to thermal oxidation than B-3V, which is based on a pentaerythrite ether of synthetic fatty acids with 1.5% captax and 0.3% p-oxidiphenyl amine antiwear and anti-oxidant additives, respectively. The deposit-forming activity of B-3V is found to decrease sharply when the p-oxidiphenyl amine content is reduced, indicating that the insoluble deposits formed upon oxidation consist

of captax oxidation products formed by reaction with p-oxidiphenyl amine. Replacing the p-oxidiphenyl amine with the phenyl-alpha-naphthyl amine anti-oxidant NG-2246 is shown to lead to greatly increased oxidation stability, while the replacement of both the anti-oxidant and antiwear additives leads to a lubricant, LZ-240, with greater antiwear, antigalling and thermal oxidation stability properties than B-3V.

A.L.W.

**A79-52546** # Aircraft motion sensitivity to dynamic stability derivatives. T. F. Langham (ARO, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1621*. 20 p. 12 refs.

The paper presents a dynamic derivative sensitivity study conducted to determine the importance of cross-coupling and acceleration damping derivatives in motion simulation of a fighter/bomber and attack-type aircraft. The study uses a 6-degree-of-freedom nonlinear motion program. Changes in aircraft response to control perturbations are discussed with both individual variations and nonlinear simultaneous variations of the cross-coupling and acceleration derivatives. Both level and 3 g turning flight conditions are considered at a trim angle of attack of 20 deg.

V.T.

**A79-52547** # Flowfield chemistry effects on stability of blunted slender cones. L. A. Cassel, R. M. Traci, and L. D. McMullen (Science Applications, Inc., Irvine, Calif.). *American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1630*. 7 p. 12 refs. Grant No. DASG60-77-C-0149.

An experiment was conducted to measure the influence of flowfield chemistry, or real gas effects on the static stability of slender blunted cones in hypersonic flight. The experiment was designed to investigate the validity of computational solutions of inviscid, equilibrium chemistry flow equations. These solutions had indicated that real gas effects would change static margin approximately one percent of body length under some conditions of geometry and flow. The results of the experiment demonstrate with reasonable confidence the existence of such a flowfield chemistry influence on stability.

(Author)

**A79-52548** # Recent results in parameter identification for high angle-of-attack stall regimes. J. H. Vincent, N. K. Gupta, and W. E. Hall, Jr. (Systems Control, Inc. /VT/, Palo Alto, Calif.). *American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1640*. 16 p. 7 refs. Contracts No. N00014-72-C-0328; No. N00014-78-C-0641.

The paper describes the application of system identification methodology to the estimation of nonlinear aerodynamic models and parameters from flight test data. Flight test data from T-2C and F-4S aircraft are used to develop and test a system identification technical approach and a set of algorithms. The technical approach includes flight data processing and analysis, model structure determination, and parameter identification. An equation error method is employed for defining significant model structures and starting parameter values for a maximum likelihood-parameter identification program, determining final parameter estimates and measurement system errors.

V.T.

**A79-52549** # Progress in mathematical modeling of the aircraft operational environment of DD 963 class ships. R. L. Fortenbaugh (Vought Corp., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1677*. 12 p. 14 refs.

The aircraft operational environment of DD 963 class ships has been quantified by mathematical models which are readily applicable

to piloted simulations and system analyses. Key assumptions, features, and intended application of the several airwake and ship motion model forms are discussed. Other topics covered include the concept and selection of compatible environmental parameters which guide the integration of ship motion and airwake data bases, spectrum tuning to maximize ship motions in given Sea States, and extrapolation of the airwake data base to free-stream conditions. Results are presented of recent Type A V/STOL piloted simulations and AV-8A unmanned simulations which establish the utility of and indicate the validity of the models. (Author)

**A79-52556 # Real-time gravity filtering from on-board gradiometers.** M. Kurosaki and J. V. Breakwell (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Guidance and Control Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1767.* 20 p. Contract No. F-19628-C-0038.

An airplane carries gradiometers which measure all components of the gravity-gradient tensor. The airplane is flying at constant speed and altitude in a constant direction, and good estimates are desired of the gravity deflection along and perpendicular to the flight direction. The gravity variations are described by the top three layers of the 5-layer statistical model of Heller (in Jordan, 1978). The estimation is analyzed by two separate methods: (1) a low-order state-space model is constructed to approximate the Heller model; (2) Wiener filter theory is used to obtain asymptotic results for high gradiometer accuracy. (Author)

**A79-52571 Aerodynamics, aeronautics, and flight mechanics.** B. W. McCormick (Pennsylvania State University, University Park, Pa.). New York, John Wiley and Sons, Inc., 1979. 666 p. 125 refs. \$25.95.

The book provides a single, comprehensive, in-depth guide to modern aerodynamics, aeronautics, and flight mechanics. It covers the fluid mechanics and aerodynamics of incompressible and compressible flows, with particular attention to the prediction of the lift and drag characteristics of airfoils and wings as well as complete aircraft configurations. Following an introduction to propellers, piston engines and turbojet engines, methods are presented to analyze the performance of an aircraft throughout its operating regime. Static and dynamic longitudinal and lateral-directional stability and control are discussed with emphasis on flying qualities. The book contains a considerable amount of data on currently operating aircraft and engines, including lift and drag data, stability derivatives, and engine performance curves. Numerical methods are emphasized throughout, and many working graphics are included.

S.D.

**A79-52608 Heat transfer over the initial section of turbine blade cooling channels under conditions of rotation.** V. I. Lokai and E. I. Gunchenko (Kazanskii Aviatsionnyi Institut, Kazan, USSR). (*Teploenergetika*, vol. 26, Feb. 1979, p. 31-34.) *Thermal Engineering*, vol. 26, Feb. 1979, p. 93-95. 13 refs. Translation.

The effects of rotation on heat transfer in the initial sections of rotating turbine blade cooling channels are investigated. Blade rotation rates on a model gas turbine were varied from 0 to 5500 rpm and inlet Reynolds numbers from 12,000 to 37,000. The change of Stanton number, determined on the basis of measurements of the local coefficient of heat transfer, Reynolds number and coolant flow, with inlet Reynolds number reveals that heat transfer increases with rotation rate, and increases at a greater rate with increasing distance from the inlet. The effects of rotation rate on heat transfer are then generalized on the basis of the theory of local simulation according to local boundary layer characteristics. A.L.W.

**A79-52675 \* # Combustor modelling for scramjet engines.** J. P. Drummond, R. C. Rogers, and J. S. Evans (NASA, Langley Research Center, Hampton, Va.). *NATO, AGARD, Specialists' Meeting on Combustor Modelling*, 54th, Cologne, West Germany, Oct. 3-5, 1979, Paper. 30 p. 43 refs.

A system of computer programs is being developed to analyse and predict the complex flow fields found in hydrogen-fueled

scramjet combustors. Each program is designed to solve the governing equation system for the type of flow present in a particular combustor region. A two-dimensional parabolic program has been found to be valuable in the development and experimental evaluation of turbulence and chemistry models for supersonic flow, and in the development of a program to model supersonic flow downstream of the fuel injection struts by means of solutions to the three-dimensional parabolic Navier-Stokes equations and species equations. A partially elliptic code has been derived to account for local subsonic flow regions, and fully elliptic programs have been developed by the consideration of streamwise diffusion effects for the recirculating flow fields near transverse fuel injectors. The programs are currently being applied to problems of scramjet engine development. A.L.W.

**A79-52694 \* # NASA/FAA general aviation crash dynamics program - An update.** R. J. Hayduk, R. G. Thomson, and H. D. Carden (NASA, Langley Research Center, Hampton, Va.). *International Society of Air Safety Investigators, Annual Seminar, Montreal, Canada, Sept. 24-27, 1979, Paper. 12 p. 15 refs.*

Work in progress in the NASA/FAA General Aviation Crash Dynamics Program for the development of technology for increased crash-worthiness and occupant survivability of general aviation aircraft is presented. Full-scale crash testing facilities and procedures are outlined, and a chronological summary of full-scale tests conducted and planned is presented. The Plastic and Large Deflection Analysis of Nonlinear Structures and Modified Seat Occupant Model for Light Aircraft computer programs which form part of the effort to predict nonlinear geometric and material behavior of sheet-stringer aircraft structures subjected to large deformations are described, and excellent agreement between simulations and experiments is noted. The development of structural concepts to attenuate the load transmitted to the passenger through the seats and subfloor structure is discussed, and an apparatus built to test emergency locator transmitters in a realistic environment is presented. A.L.W.

**A79-52718 Computer analysis of semi-monocoque shell sections.** Z. Sheps, A. I. Raibstone (Israel Aircraft Industries, Ltd., Lod, Israel), and M. Baruch (Technion - Israel Institute of Technology, Haifa, Israel). *Computers and Structures*, vol. 9, Sept. 1978, p. 305-313.

A computer program for the analysis of semimonocoque structures loaded through a rigid bulkhead is presented. The program computes the structure's principal moments of inertia, principal axes, shear center, and torsional rigidity as well as its shear flows and inertial axial loads. Furthermore, the program can convert forces and moments at one of the structure ends into a system of statically equivalent forces acting on the grid points of this region. This option is essential when a structural analysis is continued utilizing the finite methods, and the boundary conditions of the structure must be accurately defined. V.T.

**A79-52758 # Analytical-kinetic models for the evaluation of polluting emissions from aircraft gas turbines - Limiting techniques (Modele analitic-kinetic pentru evaluarea emisiilor poluante de la turbomotoarele de aviatie - Tehnici de limite).** C. Turcanu and A. Nica (Institutul National de Motoare Termice, Rumania). *Studii si Cercetari de Mecanica Aplicata*, vol. 38, Jan.-Feb. 1979, p. 125-139. 19 refs. In Rumanian.

Physical aspects of the combustion process and oxidation kinetics for two distinct cases are considered: estimating the quantity of unburned hydrocarbons and the carbon monoxide emission, and the level of nitrogen oxides. The gasdynamic model for burning gases flow in the combustor and the kinetic model for the pollution emissions are described, together with the efficiency of the pollution control techniques and the role of the afterburner. A comparison is made between theoretical calculations and some experiments. N.D.

**A79-52856 The technology of brazing and soldering is broad-based and vital to the industrial economy /1979 Adams Lecture/.** G. M. Slaughter (Oak Ridge National Laboratory, Oak

## A79-52866

Ridge, Tenn.). (*American Welding Society, Annual Meeting, 60th, Detroit, Mich., Apr. 2, 1979.*) *Welding Journal*, vol. 59, Oct. 1979, p. 17-28. 25 refs. Contract No. W-7405-eng-26.

This paper deals with filler metal selection, fluxes and protective atmospheres, joint design, heating equipment, and inspection methods required for proper brazing and soldering, and gives specific examples of brazed and soldered components. Characteristics of filler metals and solders such as wetting ability and suitable melting and flow properties, and typical brazing and soldering compositions and their melting ranges are described. Fluxes used to remove residual compounds and controlled atmospheres to prevent oxidation are discussed, noting that the AWS has classified them according to composition and applicability. The heating methods, including torch, furnace, induction, and dip-brazing are examined, and placement of filler metal by assembly and fixturing are considered. Finally, applications in the automotive, aircraft, production of ceramic-to-metal joints, and consumer product fields are illustrated by examples.

A.T.

**A79-52866** Augmented turbofan performing well in test series. W. C. Wetmore. *Aviation Week and Space Technology*, vol. 111, Oct. 15, 1979, p. 70, 71, 73.

The features and present test status of the F404-GE-400 augmented turbofan for the Navy-McDonnell Douglas-Northrop A/F-18-A are surveyed. Attention is given to the design philosophy of simplicity through application of technology, by a comparison with the GE-J79 which is in the same thrust class. Examples cited include: one third less parts than the J79 and the obtaining of twice the compression ratio with half the number of stages resulting in an engine whose entire turbomachinery could fit in the space of the J79 compressor section. Also discussed are steps in the test procedure such as: simulated mission endurance (SMET), accelerated mission test (AMT), running to service limits, and analysis of a large number of high-time hardware samples. Finally, air start capability, maintenance time and engine changes are covered.

M.E.P.

**A79-52874** # Behaviour of a two-dissimilar unit imperfect standby system with connected switching and priority repair. N. K. Jaiswal (Indian Statistical Institute, New Delhi, India) and A. Kumar (Defence Science Laboratory, Delhi, India). *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 59, July 1979, p. 323-326. 8 refs.

Operational requirement failures of a switching device are examined including the dynamic switch (DSF) and connected switch failure (CSF). A 2-unit standby redundant system with dissimilar units, DSF and CSF, and priority in repair of CSF is discussed together with the functions of the main unit. The model is an extension of Kumar's model (1977) because it deals with dissimilar units, and employs the supplementary variable technique to obtain various parameters such as, first passage time distribution to system failure, and mean time to system failure.

C.F.W.

**A79-52885** Utilization of computerized EMC techniques to evaluate C-E system to environment compatibility. M. A. Skeath and J. B. Scott (ITT Research Institute, Electromagnetic Compatibility Center, Annapolis, Md.). In: Conference on Electromagnetic Compatibility, Guildford, Surrey, England, April 4-7, 1978, Proceedings. London, Institution of Electronic and Radio Engineers, 1978, p. 143-156. 5 refs.

The paper examines the four steps in a typical system to environment EMC analysis: environment definition, environment reduction, engineering analysis, and engineering recommendations. Emphasis is placed on what can be done practically, based on the availability of EMC data and the state of the art in the development and automation of mathematical models for engineering analysis. Actual examples reviewed to illustrate the analysis process involve the evaluation of the Air Traffic Control Radar Beacon System (ATCRBS). Computerized performance prediction models are used

in EMC analysis of system parameters, system operation, and planned improvements.

M.E.P.

**A79-52887** The determination of margins of safety for critical aircraft systems. G. M. Smith (Aeroplane and Armament Experimental Establishment, Boscombe Down, Wilts., England). In: Conference on Electromagnetic Compatibility, Guildford, Surrey, England, April 4-7, 1978, Proceedings. London, Institution of Electronic and Radio Engineers, 1978, p. 189-196.

The problems of the certification of military aircraft for service with electronic equipment in primary flight safety areas are examined. Recent aircraft designs introduced complex electronic equipment into engine and flight control systems, and the present equipment susceptibility tests safety margins are not quantified. Sources of electromagnetic fields produced by communication, radar, and other aircraft, and their paths of interference are depicted, noting that the optimum method to establish a safety margin is to compare the equipment susceptibility levels with the levels experienced in the installation. Current injection tests on the signal and control inputs during qualification testing can be used to quantify the conditions during radiated susceptibility tests. An initial specification of the cable currents likely to be met in an aircraft can be obtained from aircraft surveys, but an understanding of the mechanism of the generation of internal fields will ultimately be required.

A.T.

**A79-52888** The investigation of aircraft interference problems. R. V. Pankhurst, M. B. Redman, and G. M. Smith (Aeroplane and Armament Experimental Establishment, Boscombe Down, Wilts., England). In: Conference on Electromagnetic Compatibility, Guildford, Surrey, England, April 4-7, 1978, Proceedings. London, Institution of Electronic and Radio Engineers, 1978, p. 199-204.

The effective solution of interference effects found in military aircraft requires that such effects be reproduced in a laboratory where access to the equipment is possible. The results of an initial investigation into the form of interference likely to be incident upon an installed equipment are shown together with the results of investigations into the form of equipment susceptibilities. Some general principles on design considerations for analogue equipments are given.

(Author)

**A79-52889** Electrical bonding problems in aircraft. J. Brettell and M. I. Corr (Plessey Co., Ltd., Allen Clark Research Centre, Towcester, Northants., England). In: Conference on Electromagnetic Compatibility, Guildford, Surrey, England, April 4-7, 1978, Proceedings. London, Institution of Electronic and Radio Engineers, 1978, p. 229-237. Research sponsored by the Ministry of Defence (Procurement Executive).

The achievement of reliable low-impedance electrical bonds is of prime importance in advanced aircraft. The paper discusses the general requirements for electrical bonds in aircraft, along with a more detailed consideration of the requirements of specific types, e.g., lightning conduction, static grounding, etc. The specific types of bonds discussed include high- and medium-current bonds, zero-volt reference bonds, static bonds, RF bonds, and aircraft skin bonding. The construction and properties of bonds are examined in terms of mechanical design and corrosion prevention. Experience with electrical bonding problems is briefly considered. The importance of reliable bonding will increase in the future as pertinent trends in avionic systems continue to develop.

S.D.

**A79-52891** The penetration of electromagnetic fields into aircraft from externally mounted HF antennas. M. S. Smith (Royal Aircraft Establishment, Radio and Navigation Dept., Farnborough, Hants., England). In: Conference on Electromagnetic Compatibility, Guildford, Surrey, England, April 4-7, 1978, Proceedings. London, Institution of Electronic and Radio Engineers, 1978, p. 271-280. 18 refs.

London, Institution of Electronic and Radio Engineers, 1978, p. 271-280. 18 refs.

Aircraft HF radio is a source of interference to the rest of the avionic installation. An approximate analytical/numerical treatment has been evolved for the calculation of electric and magnetic fields outside the aircraft due to HF transmissions. Penetration of these fields into the aircraft interior via electrical apertures in the aircraft skin is analyzed by a quasi-static method. Electromagnetic fields in the cockpit area of a small aircraft fitted with a tail-fin HF notch antenna have been determined and values of about 5 V/m are obtained inside the cockpit at frequencies near the aircraft resonance. Implications on electromagnetic susceptibility specifications are discussed.

(Author)

**A79-53070** Reliability analysis for optimum design. A. O. Payne and A. D. Graham (Aeronautical Research Laboratories, Melbourne, Australia). *Engineering Fracture Mechanics*, vol. 12, no. 3, 1979, p. 329-346. 29 refs.

A reliability procedure is proposed in which design is carried out for a given life time with a calculated probability of survival, taking maintenance procedures into account. It is considered to be a realistic approach to achieving optimum design and minimizing costs. In this approach the risk of failure, defined as the probability of failure at the life time in the remaining population, is calculated as a function of life time (the risk function), taking into account the variability in strength properties of the system, and the spectrum of fluctuating loads it will encounter in service. The approach is illustrated by two applications: assessment of ultimate load design procedures for an offshore drilling unit, and the derivation of a reliability-based inspection procedure for a crop-dusting aircraft. S.D.

**A79-53226** T-tails and top technology. D. Velupillai. *Flight International*, vol. 116, Oct. 13, 1979, p. 1219-1222.

The article examines the benefits and disadvantages of T-tails, which represent a growing trend, as well as winglets intended as a means of improving aircraft performance. T-tail benefits discussed include getting the tailplane out of the downwash of air from the wing thus making it more effective, and getting the tailplane out of the efflux of the engine. It is noted that the last point is important for aircraft employing fuselage mounted engines due to minimized asymmetry in the event of engine failure. Disadvantages cited include the susceptibility of some configurations to deep, or stable, stall. Finally, advantages of winglets are covered and include reduced drag and the ability to increase the load a wing can carry.

M.E.P.

**A79-53261** Solar thermal aerostat research station /STARS/. E. C. Okress and R. K. Soberman (Franklin Institute, Franklin Research Center, Philadelphia, Pa.). *International Astronautical Federation, International Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979, Paper 79-35*. 12 p. 14 refs.

The paper introduces the concept of a large, constant volume, solar powered, warm air, spherical rigid navigable aerostat able to remain aloft in the stratosphere for many years. Equipped with compressed stratospheric air for energy storage, it will be capable of performing, on a 24-hour basis, a wide variety of missions, including surveillance, solar energy generation and radiation or particle beam transmission to the surface, environmental monitoring, local weather modifications, long-range communications and microwave power relay, nighttime target illumination, weapons platform of high energy requirements, platform for aircraft launch and recovery, platform for space hardware and reusable spacecraft catapult launching, etc. Most, if not all, of these numerous missions may be conducted simultaneously, due to the unprecedented lift capability of the proposed stratoscraft. With solar energized compressed air and electric thrusters, it will be capable of 24 hours navigation and hovering in the stratosphere in most regions about the earth, and throughout the year, for many (e.g., about 10) years.

(Author)

**A79-53355 \*** Non-flammable polyimide materials for aircraft and spacecraft applications. J. Gagliani (Solar Turbines International, San Diego, Calif.) and D. E. Supkis (NASA, Johnson Space

Center, Houston, Tex.). *International Astronautical Federation, International Astronautical Congress, 30th, Munich, West Germany, Sept. 17-22, 1979, Paper 79-204*. 24 p.

Recent developments in polyimide chemistry show promise for producing materials with very low flammability and a wide range of mechanical properties. Polyimide foams can be synthesized to provide fire safety without detectable formation of smoke or toxic byproducts below 204 C (400 F), thus avoiding an environment which is lethal to human habitation. This work has been and is currently being performed under development programs, the objective of which is to provide cost effective processes for producing thermally stable, polyimide flexible resilient foams, thermal-acoustical insulating materials, rigid low density foam panels, and high strength foam structures. The chemical and physical properties demonstrated by these materials represent a technological advancement in the art of thermally stable polyimide polymers which are expected to insure fire protection of structures and components used in air transportation and space exploration. Data compiled to date on thermal, physical and functional properties of these materials are presented.

(Author)

**A79-53517** Measurement of aircraft wakes at 250-meter altitude with a 10.6-micron CW laser Doppler velocimeter. D. Burnham, J. Hallock, I. McWilliams, J. Fantasia, and B. Winston (U.S. Department of Transportation, Transportation Systems Center, Cambridge, Mass.). In: *Electro-Optics/Laser Conference and Exposition*, Boston, Mass., September 19-21, 1978, Proceedings.

Chicago, Industrial and Scientific Conference Management, Inc., 1978, p. 354-357. 5 refs.

The paper deals with the principles of operation, description, data processing, and status of data collection for a mobile CW laser Doppler velocimeter (LDV). Besides yielding good high-altitude vortex data, this LDV is being used to collect data on the wakes of aircraft landing at Chicago's O'Hare International Airport. The LDV makes a remote measurement of atmospheric wind by focusing CW 10.6-micron laser radiation into a small volume of space. The LDV is set beneath the flight path for aircraft landing on a runway, with a nominal aircraft altitude of 250 m. The novel scan mode, which takes advantage of the relative speeds of range and angle scanning in a focusing CW LDV, is proving to be valuable.

S.D.

**A79-53555** Innovative developments in demonstrative evidence techniques and associated problems of admissibility. M. A. Dombroff (U.S. Department of Justice, Civil Div., Washington, D.C.). *(Annual Air Law Symposium, 13th, Dallas, Tex., Mar. 22-24, 1979.) Journal of Air Law and Commerce*, vol. 45, no. 1, 1979, p. 139-166. 108 refs.

The use of imaginative evidence is an effort that is limited in large part by the imagination of the trial lawyer. It is shown by illustrations from air law that the conventional legal principles regarding admissibility are applicable whether blackboard drawings or videotapes are involved. The keys to admissibility are: (1) recognition of those elements of the case that require and are susceptible to the use of demonstrative evidence, and (2) an ability to properly prepare the evidence out of court and lay the proper foundation in court.

B.J.

**A79-53556** Defining the design defect in aircraft products liability cases. A. R. Abramson (Abramson and Bianco, San Francisco, Calif.). *(Annual Air Law Symposium, 13th, Dallas, Tex., Mar. 22-24, 1979.) Journal of Air Law and Commerce*, vol. 45, no. 1, 1979, p. 167-185. 108 refs.

Aircraft and component manufacturers, along with sellers and lessors, are liable in tort when their product contains a design defect which causes injury. Courts have developed three theories covering responsibility for damages: negligence, breach of warranty, and strict product liability. This paper reviews these three aspects of liability.

B.J.

**A79-53557** **A review of crashworthiness.** G. Galerstein (Bell Helicopter Textron, Fort Worth, Tex.). (*Annual Air Law Symposium, 13th, Dallas, Tex., Mar. 22-24, 1979.*) *Journal of Air Law and Commerce*, vol. 45, no. 1, 1979, p. 187-216. 128 refs.

The courts' interpretation of the crashworthiness doctrine is examined with particular reference to the manufacturer's conscious design choice. It is concluded that the subject of crashworthiness is one of extreme complexity involving subtle tradeoffs and balancing of numerous antithetical, socially desirable values. B.J.

**A79-53621** **# Analysis of vehicles with wings operating in ground effect.** H. V. Borst. In: *Advanced Marine Vehicles Conference*, Baltimore, Md., October 2-4, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 136-144. 18 refs. (AIAA 79-2034)

The paper discusses the existing theoretical methods and data for the design and performance analysis of vehicles using wings operating in ground effect, WIG. These WIG vehicles derive improved lift drag ratios as a result of the decreased induced drag losses from the reduction of downwash velocity due to the ground effect and increased lift due to ram either from the forward motion or directly from power. The existing theoretical methods are given and are used to predict performance for comparison with tests. The comparison shows that the lift drag ratios measured especially at low ground clearances are better than predicted based on theory. Possible procedure for improving the comparison are given. Using the conservative theoretical methods, the size and performance of competitive water-based vehicles are determined. The fundamental design problems of the WIG configuration are discussed and the need for power augmentation of the ram flow, PAR, is given. Using the PAR-WIG concept, practical high performance vehicles can be developed. (Author)

**A79-53622** **# Naval architectural considerations in the design of a helicopter.** J. C. Daidola, D. A. Graham (M. Rosenblatt and Son, Inc., New York, N.Y.), and B. B. Blake (Boeing Vertol Co., Philadelphia, Pa.). In: *Advanced Marine Vehicles Conference*, Baltimore, Md., October 2-4, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 180-187. 19 refs. (AIAA 79-2013)

This paper describes the methods for determining the waterborne performance of a helicopter during emergency ditching. The waterborne motions and their analysis with predictions based on the mass, damping, and buoyancy stiffness characteristics of the helicopter, the intact and damaged stability, and methods for predicting the seaway impact pressures are discussed. Stability of the helicopter is analyzed by applying the criteria for ships and advanced vehicles of several ship classification societies and the U.S. Navy. Waterborne motions are determined by the strip theory and superposition techniques used in naval architecture, and several procedures developed for predicting impact loads are considered for their applicability to helicopters. It is concluded that the existing motion and stability analytical methods used in naval architecture can be applied in the analysis of a waterborne helicopter, but procedures and test data for predicting impact loads on high performance craft should be applicable, but should be compared to model tests which should consider helicopter hull forms, aerodynamic lift, and structure. A.T.

**A79-53626** **Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.** Meeting sponsored by the American Helicopter Society. Washington, D.C., American Helicopter Society, 1979. 138 p. \$15.

Helicopter flight controls are discussed with respect to requirements, component technology, and system and subsystem implementation. Particular consideration is given to the impact of flight controls research on future civil helicopter operating efficiency and safety, power by wire for aircraft, and Automatic Stabilization Equipment for the YAH-64 Advanced Attack Helicopter. B.J.

**A79-53627** **# Flight controls/avionics research - Impact on future civil helicopter operating efficiency and mission reliability.** W. J. Snyder and J. V. Christensen (NASA, Ames Research Center, Helicopter Systems Office, Moffett Field, Calif.). In: *Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.* Washington, D.C., American Helicopter Society, 1979. 12 p. 8 refs.

Operational efficiency and mission reliability are key capabilities which will impact the future use of helicopters in the civil segment and areas where flight control/avionics research can play a major role. The present paper reviews flight control/avionics system needs for each major area of civil helicopter use. Technology requirements to meet civil needs are discussed. The review points up the need for the development of all-weather flight control concepts and the validation of cost effective active control/fly-by-wire/fly-by-light system concepts with modular architecture which can be tailored to specific mission requirements. B.J.

**A79-53628** **# Military considerations for helicopter flight controls.** G. W. Shallcross (U.S. Army, Fort Rucker, Ala.). In: *Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.* Washington, D.C., American Helicopter Society, 1979. 9 p.

A review is made of a typical Air Cavalry combat operation in which the flight control system was deficient. The deficiencies of the helicopter flight control systems are discussed along with considerations of what future requirements are needed to improve flight controls. B.J.

**A79-53629** **# Three basics of design for civil certification.** J. D. Erickson (FAA, Fort Worth, Tex.). In: *Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.* Washington, D.C., American Helicopter Society, 1979. 4 p.

Three elements of civil helicopter certification are discussed: control, stability, and flight envelope. Flight control design dictates the success or failure of each of these elements. The three elements should not be considered individually as one cannot be changed without affecting the other two. New designs should foster greater control, stability, and flight envelope through increased pilot/designer interface. B.J.

**A79-53630** **# A direct drive fly-by-wire system.** G. D. Jenney (Dynamic Controls, Inc., Dayton, Ohio). In: *Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.* Washington, D.C., American Helicopter Society, 1979. 9 p.

This paper describes a Fly-By-Wire (FBW) control system mechanization which uses a particular type of electrohydraulic valve in order to create a simple FBW control system. The system as developed is a single fail operate mechanism, analogous to the two parallel channels of a conventional flight control system. Because of the simplicity and potential low cost of this type of system, the mechanization is attractive for helicopter application. (Author)

**A79-53631** **# Power by wire for aircraft - The all-electric air vehicle.** C. W. Helsley, Jr. (Rockwell International Corp., El Segundo, Calif.). In: *Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers.* Washington, D.C., American Helicopter Society, 1979. 17 p. 12 refs.

With the advent of high specific output, low inertia, rare-earth permanent magnet-type electric motors, the aircraft actuation field was reopened to electric motors. This in turn made possible the 'all-electric' aircraft and significant power system (generation and distribution system) weight savings. It is shown that, through the proper selection and application of various electromechanical actuation arrangements (i.e., mechanical servo power packages, mechanical power packages, electric servo motors, etc.), significant amounts of weight can be saved on large high-performance fixed wing aircraft

and that respectable weight savings can also be made on helicopters. It is shown that the total weight savings on the B-1 aircraft, as a result of converting to the 'all-electric' air vehicle configuration, is 1,642 pounds. B.J.

**A79-53632 # Optical control technology.** J. R. Goodman (Bell Helicopter Textron, Fort Worth, Tex.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. Washington, D.C., American Helicopter Society, 1979. 5 p.

This paper presents the results of research aimed at using fiber optics to make fly-by-wire control systems immune to EMI, RFI, lightning, and other electrically related disturbances. It presents an introduction into fiber optic operation, signal transfer techniques, and the rationale for selecting a fiber optic (FO) control signal path. A research project involving embedding the fiber optical material into the composite helicopter structure is discussed. The design and flight test of an optical position encoder, decoder, and FO cable is presented. Finally, several electrically passive FO position transducers are discussed. (Author)

**A79-53634 # STAR flight control system.** G. Carlock, C. M. Gatlin, K. F. Guinn (Bell Helicopter Textron, Fort Worth, Tex.), and R. D. Borgeson (Textron, Inc., Hydraulic Research Div., Valencia, Calif.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. Washington, D.C., American Helicopter Society, 1979.

10 p.

The STAR fly-by-wire system is a unique five-channel swashplate control system. The name 'STAR' is derived from the appearance of the five-arm swashplate employed. Each of the swashplate arms is attached to a hydraulic actuator that is electronically controlled by a dedicated control channel. Each of the five control channels has electric and hydraulic power supplies, pilot input sensors, drive electronics, and self-monitoring. Each channel is thus self-sufficient and isolated from the other four channels except for failure condition information that is shared between channels via fiber optic transmission links. The STAR concept has progressed to the state of experimental hardware and is undergoing design verification tests on an Iron Bird integration test stand. B.J.

**A79-53635 # Fly-by-wire tail rotor controls.** W. Stephens (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.) and B. J. Hampton (Bell Helicopter Textron, Fort Worth, Tex.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. Washington, D.C., American Helicopter Society, 1979. 8 p.

The paper describes a program intended to develop fly-by-wire controls uniquely applicable to helicopter tail rotors. Single fail-operate redundancy is provided by three electric motors mounted at the tail rotor gearbox. Each motor drives through a simple mechanical torque breakout device into a single gear attached to a control quill, which converts rotary motion to linear motion. The torque breakout devices provide failure management in the mechanical components; therefore, the electronics can be kept simple and inexpensive. Three independent electrical circuits provide serial summing of signals from the pilot's position transducer, tail rotor pitch-change position transducer, and the stability and control augmentation system, in order to command the motors. A dual monitor warns the pilot of a failure in a specific channel. B.J.

**A79-53636 # Actuator and hydraulic survivability concepts for Hughes YAH-64.** R. A. York, R. E. Molloy, and E. G. Adler (Bertea Corp., Irvine, Calif.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. Washington, D.C., American Helicopter Society, 1979. 10 p.

The task assigned to the hydraulic and flight control actuation system of the YAH-64 Advanced Attack Helicopter is to provide a conventional hydraulic system, invulnerable to battle damage, with

superior performance and reliability. The design philosophy of this system is reviewed, with particular emphasis on system concepts incorporated in the flight control hardware for the purpose of surviving malfunctions or battle damage. A summary of the various configurations that were tested and the results of ballistic tests on development hardware configurations are presented. B.J.

**A79-53637 # Automatic Stabilization Equipment for the Army/Hughes YAH-64 Advanced Attack Helicopter.** J. E. Engle (Sperry Flight Systems, Phoenix, Ariz.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. Washington, D.C., American Helicopter Society, 1979. 7 p.

The Automatic Stabilization Equipment (ASE) for the YAH-64 provides a tailored combination of controllability, and stability in all flight regimes, from low speed NOE flight to high speed point-to-point flight. A description is given of the design features which provide stability for hands-off flying, control command augmentation for maneuvering agility, and a fly-by-wire back-up control system for safety and survivability. B.J.

**A79-53638 # CH-53E digital automatic flight control system.** R. D. Murphy (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Specialists Meeting on Helicopter Flight Controls, Arlington, Tex., October 11-13, 1978, Technical Papers. (A79-53626 24-08) Washington, D.C., American Helicopter Society, 1979. 8 p.

The CH-53E system represents the first digital automatic flight control system in a production helicopter. This paper examines the development and testing of the new digital system, with attention given to design in terms of both hardware and software. Consideration is given to hardware and software structure, the redundancy management scheme, and self-test features. The validation of the design in flight and in formal reliability tests is discussed along with the results achieved. B.J.

**A79-53720 \* # Composites emerging for aeropropulsion applications.** G. M. Ault and J. C. Freche (NASA, Lewis Research Center, Cleveland, Ohio). *Astronautics and Aeronautics*, vol. 17, Oct. 1979, p. 48-59, 80, 81. 47 refs.

The paper deals with applying composites to the cold- and hot-section components of aircraft turbine engines and analyzing composite structures. The primary experience to date has been with graphite-epoxy materials. The emerging new composites based on fabricable polyimides will find application in components that can operate at temperatures higher than the 350 F allowed by the epoxies. Further major benefits would result if the fiber-reinforced polymer composites could be used for key rotating components, such as the fans of large high-bypass-ratio engines. For the very critical hot turbine components, fiber-reinforced superalloys for turbine blades are considered. V.T.

**A79-53722 # Flammability of cabin furnishing materials.** J. M. Ramsden. *Flight International*, vol. 116, Oct. 6, 1979, p. 1099-1101.

The results of flammability testing of cellular plastic cabin furnishings are surveyed. It is noted that many survivable accidents have been fatal, with death resulting from fire or smoke rather than from impact. It is reported that tests carried out by the United Kingdom Fire Research Station have found that the burning of polyurethane foam in bulk quickly generates very high temperatures and thick smoke, with flames at least 12 meters from the polyurethane. Temperatures of over 1,000 C and higher were reached melting the steel plated flooring of the test rig. Other hazards in addition to smoke and carbon monoxide are the production of hydrogen cyanide and other toxic gases. In addition, an American NTSB report, citing the use of kerosene type fuels as a factor in reduced fatalities due to fire and smoke, is covered. Finally, attention is given to future research such as the feasibility of non-flammable cabin attendant uniforms. M.E.P.

**A79-53723** Measuring metres to the target. *Flight International*, vol. 116, Oct. 6, 1979, p. 1129-1132, 1134.

Weapons aiming systems for ground attack are surveyed. Attention is given to two basic air to ground models: Continuously Computed Impact Point (CCIP) and Continuously Computed Release Point (CCRP). Systems discussed include lead-computing gyro gunsights, Saab's RGS4, Ferranti's Isis, Hudwacs, Thomson-CSF, Marconi Avionics HUD, Decca, Sperry Doppler twin gyro platform nav/attack system, and Sagem units. Also covered are the Israel Industries WDNS-141 inertial weapon delivery and navigation system, the Martin Marietta Pave Penny, and Westinghouse Pave Spike units. It is concluded that the cost effectiveness of a system depends on the cost of aircraft and that an expensive system can make a small number of high performance, high cost aircraft as effective as a larger fleet of less well-equipped aircraft. M.E.P.

**A79-53728** A study of some characteristics of the operation of a lifting propeller by numerical experiment. S. M. Belotserkovskii, V. A. Vasin, and B. E. Loktev. (*Akademii Nauk SSSR, Doklady*, vol. 244, Jan. 11, 1979, p. 312-315.) *Soviet Physics - Doklady*, vol. 24, Jan. 1979, p. 12-14. 7 refs. Translation.

The present analysis deals with such special modes of rotor operation as sudden braking during axial descent, sudden rapid changes in altitude in the upward and downward directions, and hover, or longitudinal flight, in the presence of the ground effect. Some characteristics of operation under such conditions are identified for a two-bladed rotor with rigid flat rectangular blades. V.P.

**A79-53750 \* #** An overview of NASA research on positive displacement type general aviation engines. E. E. Kempke and E. A. Willis (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1824*. 38 p. 12 refs.

The paper surveys the current status of the aviation positive displacement engine programs underway at the NASA Lewis Research Center. The program encompasses conventional, lightweight diesel, and rotary combustion engines. Attention is given to topics such as current production type engine improvement, cooling drag reduction, fuel injection, and experimental and theoretical combustion studies. It is shown that the program's two major technical thrusts are directed toward lean operation of current production type spark ignition engines and advanced alternative engine concepts. Finally, an Otto cycle computer model is also covered. M.E.P.

**A79-53771** Wing center section optimization with stress and local instability constraints. M. Isreb (Riyadh, University, Riyadh, Saudi Arabia). *Computers and Structures*, vol. 10, Dec. 1979, p. 855-861. 13 refs.

This paper considers the optimization of bar/shear panel/unidirectionally stiffened panel idealization finite element model of the wing center section of an airplane. The finite element model is synthesized with respect to stress and local instability constraints. The paper introduces more realistic and flexible synthesis approach over the previous published work. (Author)

**A79-53773** Optimal design of wing structures with substructuring. A. K. Govil (Iowa, University, Iowa City, Iowa; M.N.R. Engineering College, Allahabad, India), J. S. Arora, and E. J. Haug (Iowa, University, Iowa City, Iowa). *Computers and Structures*, vol. 10, Dec. 1979, p. 899-910. 17 refs. Army-supported research.

An iterative method for optimal design of large scale structures that incorporates the concept of substructuring is extensively applied to wing-type structures to demonstrate its generality, effectiveness and efficiency. Optimum designs for several wing-type structures are obtained and compared with results available in the literature. It is shown that considerable efficiencies can be achieved by integration of the substructuring concept into a structural optimization algorithm. (Author)

**A79-53855** System capacity of the approach- and landing aid SETAC (Systemkapazität der Anflug- und Landehilfe SETAC). H.-J. Fischer (Braunschweig, Technische Universität, Braunschweig, West Germany). *Frequenz*, vol. 33, Sept. 1979, p. 253-258. 8 refs. In German.

In the course of development of the SETAC- system theoretical investigations about system-behavior under traffic loading were carried out. This article describes a mathematical model of SETAC operation and the necessary data for this model are summarized. As a result of this simulation maximum ratings of the number of aircrafts served reliably (a destinated reply efficiency) by one SETAC ground station are quoted. (Author)

**A79-53870 #** Airplane brake-energy analysis and stopping performance simulation. M. K. Wahi (Boeing Commercial Airplane Co., Seattle, Wash.). *Journal of Aircraft*, vol. 16, Oct. 1979, p. 688-694. 7 refs. Research supported by the Boeing Commercial Airplane Co.

A digital simulation representing airplane dynamics under braking action has been developed. The basic equations of motion represent a rigid-body airplane with the forward, vertical, and pitch degrees of freedom. The landing-gear representation utilizes linear springs and dampers. Effects of engine transients, i.e., spinup and spindown, engine failure, reverse thrust, friction variation with velocity (wet runway), pitch dynamics and associated load transfer between gears, and flap-spoiler settings have been accounted for. The program is called LANRTO and is capable of computing maximum potential brake energies (100% braking efficiency) and stopping distances under landing and refused takeoff conditions for jet transport airplanes. The simulation is compatible with the certification procedures of both military (MIL-W-5013H and ASD-TR-68-56) and commercial (FAR 25, FAR 37/TSO-C26b) regulations. Good correlation has been achieved between results of this simulation and those of an analog-hardware brake control simulator. (Author)

**A79-53871 #** Formulas for spanwise distribution of lift on aircraft wings. W. C. Obi (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). *Journal of Aircraft*, vol. 16, Oct. 1979, p. 733-736.

The discrete numerical solution of the integral equation for total known wing lift as a function of distance along the wing span and of load source (angle of attack) is considered. The integrand is treated as a point on a hyperplane, and a formula for the specification of the solution is derived in terms of two indeterminate vectors. These vectors are shown to correspond to physically significant quantities which can be computed or measured beforehand, and also to be useful in approximations when aerodynamic data are not available. The formula is applied to the estimation of the spanwise lift distribution for a wing at subsonic speeds and different values of total lift. The formula is considered to be a simple means of achieving accurate design estimates in a wide range of engineering approximations of detailed function distributions from their definite integrals. A.L.W.

**A79-53889** Advanced composites for turbines. A. J. Wilson (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *ManTech Journal*, vol. 3, no. 4, 1978, p. 11-16.

Applications of advanced composite materials in engine design are reviewed. Glass/epoxy composites were used in the CF6 engines in low stress, low temperature applications where it provided long life with minimal maintenance at lower weight and cost than metal components. The Quiet Clean Short Haul Experimental Engine program for NASA developed a graphite/epoxy fan frame designed for a maximum stress of over 100,000 psi, the inner duct made of graphite/polyimide for a temperature over 500 F which is the largest engine component built from this material, and a graphite/epoxy, Kevlar fabric, glass, and boron fiber fan blade designed to rotate 180 deg to provide reverse thrust. Finally, a graphite/polyimide composite is evaluated to replace titanium for the duct on the F404 engine to achieve weight reduction, and for the inlet particle

separator of the T700 engine required to withstand the high pressures and temperatures of the anti-icing air. A.T.

**A79-53890** Composite rotors - An evolving art. P. F. Maloney (Kaman Aerospace Corp., Bloomfield, Conn.). *ManTech Journal*, vol. 3, no. 4, 1978, p. 17-21.

The current development work on composite material helicopter blades is reviewed. Composites have become attractive because of their improvements over poor durability and high life costs of metal blades which are susceptible to fatigue and corrosion failures. Epoxy-fiberglass HH43B helicopter blades, aluminum spar/fiberglass skin bonded over aluminum honeycomb core blades for the UH-2, and the fiberglass elastic pitch beam tail rotor for UH-1H helicopter are described. The current state of art is represented by the composite main rotor blade for AH-1 whose main spar, the trailing edge spline, and the rotor blade skins are formed by automated wet filament winding; they are made of glass and organic fiber reinforced epoxy. Finally, development programs utilizing a graphite/fiberglass composite for the circulation control rotor, the composite wind turbine blade for a 300 ft diameter windmill, and a braiding technique for high rate layup are discussed. A.T.

**A79-53891** Composites for noise reduction. J. W. Lenski, Jr. (Boeing Vertol Co., Advanced Power Train Technology Group, Philadelphia, Pa.). *ManTech Journal*, vol. 3, no. 4, 1978, p. 22-26.

Application of aluminum oxide fiber reinforced magnesium for reducing vibration, noise, and deflection by stiffening helicopter main transmission housings is presented. Development of the forward transmission bevel gear housing of the forward transmission to assess the applicability of metal matrix composites for the selective stiffening of a housing is described, including the liquid metal infiltration casting process for the preparation of aluminum oxide reinforced magnesium castings, vacuum technique, and pressure compacting. Finally, joining of components by coating with aluminum and plasma arc spraying was shown to be feasible, and it was concluded that this program is promising for the full-scale development, fabrication, and evaluation of metal-matrix composite helicopter main transmission housings. A.T.

**A79-53892** Fiberglass flight controls. L. A. Fry (Boeing Co., Seattle, Wash.). *ManTech Journal*, vol. 3, no. 4, 1978, p. 27-31.

The feasibility of producing ballistic damage tolerant control systems components from composite materials is considered. The manufacturing method for chopped glass epoxy molding compound connecting link, an idler arm, and bellcranks for a helicopter flight control system is described. The process uses matched die precision molding and a fixture that combines assembly with curing. Development of a ballistic damage tolerant fiberglass tubular/sandwich bellcrank for the CH-47 helicopter, and manufacturing techniques for the bellcrank and a clevis for the AH-1G anti-torque flight control system, using a laminated prepreg fiberglass cloth for the web and chopped graphite/epoxy molding compound and glass fiber filament wound bearing races are discussed. It is concluded that this program showed the feasibility of fabricating ballistic damage tolerant fiberglass flight control parts on a production basis. A.T.

**A79-53893** Composites important to Black Hawk. J. D. Ray (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). *ManTech Journal*, vol. 3, no. 4, 1978, p. 32-36.

New applications of composites in the UH-60A Black Hawk helicopter components are presented. One third of the rotor blade is made of composites, which include a fiberglass skin, a Nomex honeycomb core, and graphite root end laminates; it also utilizes a titanium spar with a fiberglass/epoxy structural fairing. The cross beam tail rotor airfoil section is made of fiberglass and graphite/epoxy bonded to a honeycomb substructure, the spar is graphite/epoxy with the fibers oriented along the centrifugal force axis which provides twisting capability eliminating the need for pitch bearings. The cargo floor panels are made from fiberglass facing on a nonmetallic Nomex honeycomb core, and boron/epoxy reinforcing

straps were added to the cockpit support beams and stabilizer straps. New cutting technique for hard boron, and synthetic aramid fibers, the use of co-curing instead of bonding, and studies of Kevlar/epoxy compound curvature rear fuselage to produce a 35% cost saving were discussed. A.T.

**A79-53946 \*** In-flight simulation with pilot-center of gravity offset and velocity mismatch. R. F. Stengel (Princeton University, Princeton, N.J.). *Journal of Guidance and Control*, vol. 2, Nov.-Dec. 1979, p. 538-540. 6 refs. Contract No. NAS1-13502.

Similarity transformations which preserve modal characteristics and pilot's acceleration cues in in-flight simulation are presented. The model transformation for lateral acceleration matching is developed. A velocity-mismatch example, based on a VRA simulation of the Space Shuttle, illustrates that acceleration matching is achieved at the expense of mismatching in cues which are secondary to the simulated piloting task, while primarily cues are preserved. The approach is applicable for both implicit and explicit model-following, and it can easily be extended to the longitudinal case. S.D.

**A79-54031** Mathematical model and stability of hydraulic servo drive with jet-throttle regulation. A. I. Bazhenov. (*Aviatsionnaya Tekhnika*, vol. 21, no. 4, 1978, p. 11-15.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 6-9. Translation.

In the present paper, the hydrodynamic action on a fluidic tube is analyzed for various modes of servodrive operation. The block diagram of a hydraulic servodrive with a fluidic throttle governor, including the feedback from the hydrodynamic action to the fluidic tube is given and discussed. The method of logarithmic frequency characteristics, involving the construction of a stability interface, is applied to the solution of the stability problem and the problem of self-oscillations in the system. V.P.

**A79-54036** Analog modeling in studying supersonic flow around a wing and its governing analog-criteria. R. I. Vinogradov. (*Aviatsionnaya Tekhnika*, vol. 21, no. 4, 1978, p. 43-48.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 32-37. 5 refs. Translation.

**A79-54040** Basic problem of aircraft gas turbine engine analytic design. I. Yu. V. Kozhevnikov, V. O. Borovik, V. S. Ivanov, V. A. Talyzin, I. N. Agliullin, and Ia. V. Meluzov. (*Aviatsionnaya Tekhnika*, vol. 21, no. 4, 1978, p. 68-74.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 53-57. Translation.

It is proposed to separate the problem of designing gas turbine engines into a number of marginal successively solvable problems. The problem of modeling and optimizing the thermogasdynamics parameters of the engine is termed the basic problem. A solution of the basic problem yields a set of initial data for designing the elements of a gas turbine engine. The basic problem of analytical design is formulated with allowance for the influence of random factors and the multimode nature of engine operation. V.P.

**A79-54042** Selecting the geometric parameters and position of a nose flap on the root profile of a swept wing using tunnel test data. II. A. I. Marjazh, V. A. Sterlin, V. A. Popov, V. V. Isaev, and G. A. Cheremukhin. (*Aviatsionnaya Tekhnika*, vol. 21, no. 4, 1978, p. 81-87.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 62-66. 5 refs. Translation.

**A79-54044** On modeling sensitivity of a linear system to reduction of its order by the infinitesimal transformation method in the yaw motion control problem. V. G. Pavlov. (*Aviatsionnaya Tekhnika*, vol. 21, no. 4, 1978, p. 94-98.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 72-75. Translation.

The method proposed for solving the problem of sensitivity to a decrease in order of a linear system is based on the use of certain concepts of the theory of continuous groups. The idea is to imbed the initial process into a continuous set obtained by transformation

of the nominal set, and to use a lower order system as the initial one. The set of processes corresponding to higher-order systems is obtained by transformation of the initial system. The method is applied to the problem of yaw control. It is shown that sensitivity is well modeled by a continuous transformation group defined by the Lie algebra of three basis operators.

V.P.

**A79-54045** On the empennage snap-through problem. V. A. Pavlov and S. K. Chernikov. (*Aviatsionnaia Tekhnika*, vol. 21, no. 4, 1978, p. 99-104.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 76-80. 8 refs. Translation.

A mathematical model, in the form of a system of nonlinear integrodifferential equations, is derived for aircraft rudder and elevator units. A solution of this system of equations, obtained by the method of successive loads, is shown to adequately predict the conditions for rudder and elevator failure.

V.P.

**A79-54048** Motion of rectangular wing between parallel walls. K. V. Rozhdestvenskii. (*Aviatsionnaia Tekhnika*, vol. 21, no. 4, 1978, p. 117-123.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 92-97. 6 refs. Translation.

In the present paper, the method of matched asymptotic expansions is applied to the derivation of an asymptotic expression for the flow potential in the case of a rectangular wing between two horizontal parallel walls. Formulas for the lift coefficient are obtained. Numerical results illustrating the influence of the walls on the lift coefficient for a range of wing aspect ratios and wall spacings are analyzed and are found to hold for small distances between the wing and the lower wall.

V.P.

**A79-54051** Structural analysis of variable-sweep wings. N. A. Shelomov and N. A. Gorozhankin. (*Aviatsionnaia Tekhnika*, vol. 21, no. 4, 1978, p. 133-141.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 106-113. Translation.

A method is proposed for calculating wings of variable sweep on the basis of a model of a combinational system, in differential formulation. The analysis is carried out for (partitions in the form of) bevelled conical and cylindrical membrane shells located between wing ribs, making use of Obraztsov and Onanov's (1973) equilibrium equations of such shells.

V.P.

**A79-54057** Parachute-rocket deceleration system design. V. N. Semenov. (*Aviatsionnaia Tekhnika*, vol. 21, no. 4, 1978, p. 158-162.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 132-134. Translation.

In the present paper, the problem of designing a retrothrusted soft-landing system is formulated to include a design stage which tolerates a formal approach. An algorithm for solving the design problem within this stage is proposed and some results are examined.

V.P.

**A79-54058** Flow around small-aspect-ratio delta wing with vortex 'bursting'. G. A. Cheremukhin, E. A. Truneva, and E. Ia. Pivkin. (*Aviatsionnaia Tekhnika*, vol. 21, no. 4, 1978, p. 162-167.) *Soviet Aeronautics*, vol. 21, no. 4, 1978, p. 135-140. 9 refs. Translation.

In the present paper, the influence of changes in the vortex structure of the near-wake on the boundary layer flow and dynamic characteristics of a small-aspect-ratio delta wing is analyzed. The relationship between the state of vortex filament and the flow at the wing surface is examined. It is shown that vortex breakdown affects appreciably both the pressure distribution and the aerodynamic behavior of the wing.

V.P.

**A79-54200** The future of the helicopter. J. C. Appleyard (DMS, Inc., Greenwich, Conn.). *Exxon Air World*, vol. 31, no. 3, 1979, p. 20-23.

A forecast of the world market for commercial helicopters is surveyed. The major conclusion of the study is that the helicopter

market, particularly the commercial segment, will experience unprecedented growth during the 1980's. It is predicted that the free world's military helicopter inventory will increase 22.7% to 23,278 units, while the commercial helicopter inventory will increase 154% to 25,815 units. In addition, it is predicted that the most significant market for helicopters will be for single turbine units under 6000 pounds. Some 10,543 units valued at \$2.64 billion are projected during the period. Finally, findings on commercial helicopter trends are summarized for five major regions of the world: Australasia, Europe, Latin and South America, Middle East and Africa, and North America.

M.E.P.

**A79-54226** Structural adhesives and bonding; Proceedings of the Conference, El Segundo, Calif., March 13-15, 1979. El Segundo, Calif., Technology Conferences Associates, 1979. 448 p. \$33.

The present volume deals with the theoretical aspects of adhesive bonding, the properties of structural adhesives, the processes employed, and the major applications of adhesive bonding. The evolution of structural adhesives is reviewed. Among the topics covered are the critical factors affecting the stress durability of adhesive bonds, fatigue testing of structural adhesives, approaches to the study of adhesive interface phenomena and bond strength, methods of predicting bond strengths, and the effect of contamination and process errors on bond strength and durability.

V.P.

**A79-54232** Chemical analysis of structural adhesives and resins for composites. D. Crabtree (Northrop Corp., Aircraft Group, Hawthorne, Calif.). In: *Structural adhesives and bonding; Proceedings of the Conference, El Segundo, Calif., March 13-15, 1979*. El Segundo, Calif., Technology Conferences Associates, 1979, p. 93-109.

The paper deals with epoxy resins formulations of complex type. Typically, an adhesive formulation contains two or more epoxy resins, a curing agent, rubber (for toughness), and fillers (for flow and corrosion control). Typically, a composite resin formulation contains two or more epoxy resins and a curing agent. These complex multicomponent formulations are used to give the materials the required blend of tack, flow, green strength, and processing characteristics. Methods which have been found satisfactory for analyzing the chemical composition of adhesive and composite resin formulations include UV and IR spectroscopy, chromatography, and thermal analysis. Routine analysis of incoming lots of material for chemical composition is a practical operation with these procedures.

V.P.

**A79-54238** Mechanical characterization of structural adhesives. W. J. Renton (Vought Corp., Dallas, Tex.). In: *Structural adhesives and bonding; Proceedings of the Conference, El Segundo, Calif., March 13-15, 1979*. El Segundo, Calif., Technology Conferences Associates, 1979, p. 234-254. 11 refs.

Use of adhesive bonding for joining aircraft structural elements has the advantages of reducing weight and costs and eliminating stress concentrations associated with bolted structures. The present paper deals with structural adhesive mechanical characterization test procedures developed for use in aircraft industry. Particular attention is given to the analysis and design of optimum test specimens; adhesive deformation measurement systems; and data reduction procedures.

V.P.

**A79-54240** Problems in testing electrically conductive structural adhesives. S. H. Goodman and S. A. Tunick (Hughes Aircraft Co., Culver City, Calif.). In: *Structural adhesives and bonding; Proceedings of the Conference, El Segundo, Calif., March 13-15, 1979*. El Segundo, Calif., Technology Conferences Associates, 1979, p. 267-292. Contract No. F33615-77-C-5126.

The technique of establishing electrically conductive adhesive bond joints is examined. Attention is given to the degree of conductivity, and how to control, verify, and maintain it. Two

aspects are considered: (1) preparation of highly conductive bond joints, and (2) problems encountered in the development of a controlled partial or semiconductive joint. Areas discussed include measurement of conductivity, the effect of applied dc voltage, pressure and bondline thickness on resistivity and how the addition of conductive fillers and bondline thickness affects the mechanical properties of the adhesives.

M.E.P.

**A79-54241** An overview of the PABST program. E. W. Thrall, Jr. (Douglas Aircraft Co., Long Beach, Calif.). In: Structural adhesives and bonding; Proceedings of the Conference, El Segundo, Calif., March 13-15, 1979. El Segundo, Calif., Technology Conferences Associates, 1979, p. 293-339.

The Primary Adhesively Bonded Structure Technology (PABST) program was undertaken in order to achieve significant improvements in the cost, weight, integrity and durability of primary fuselage structures for wide-body aircraft through the development and validation of adhesively bonded structure technology. It has been found that the phosphoric acid anodize surface treatment is most effective in preventing adhesive failures under the test conditions studied, and environmental tests have shown FM-73 to be the most durable adhesive investigated. Structural arrangements developed for the full-scale forward section of the YC-15 fuselage include internal longerons, wide-space longerons with close frame spacing and external longerons. A stress analysis method has been developed to determine the required overlap of the skin splices, the area required in stiffeners, and frame shear tees. Pressure cycle tests have revealed the arresting and turning of a longitudinal crack, a feature which allows higher panel stresses than in riveted structures, and cycle tests have demonstrated fewer fatigue cracks in a bonded structure than in riveted structures.

A.L.W.

**A79-54273** Model tests on cooling of gas turbine blades. H.-G. Hosenfeld and O. A. v. Schwerdtner (Kraftwerk Union AG, Mülheim am Rhein, West Germany). *Siemens Forschungs- und Entwicklungsbücher*, vol. 8, no. 5, 1979, p. 278-282. 6 refs.

The experimental analysis of blade cooling problems requires test facilities suited to each particular problem in order to obtain an independent variation of influence values. It is noted however, that to carry out investigations at the high temperatures encountered in the actual turbomachinery requires excessive expenditures of time and money. A method based on the Law of Similarity is presented which shows that a reduction in temperature, and thus pressure, is possible. Finally, a test arrangement is described and typical results are illustrated by means of examples.

M.E.P.

**A79-54280 \*** A graph-theoretic method to quantify the airline route authority. Y. Chan (Pennsylvania State University, University Park, Pa.). *Transportation*, vol. 8, Sept. 1979, p. 275-291. 11 refs. Research supported by the Slator Funds for Flight Transportation; Grant No. NGL-22-009-640.

The paper introduces a graph-theoretic method to quantify the legal statements in route certificate which specifies the airline routing restrictions. All the authorized nonstop and multistop routes, including the shortest time routes, can be obtained, and the method suggests profitable route structure alternatives to airline analysts. This method to quantify the C.A.B. route authority was programmed in a software package, Route Improvement Synthesis and Evaluation, and demonstrated in a case study with a commercial airline. The study showed the utility of this technique in suggesting route alternatives and the possibility of improvements in the U.S. route system.

A.T.

**A79-54290** Exterior flow with an isoparametric Hermite cubic element. B. R. Williams (Royal Aircraft Establishment, Farnborough, Hants., England) and K. W. Morton (Reading, University, Reading, Berks., England). *International Journal for Numerical Methods in Engineering*, vol. 14, no. 10, 1979, p. 1499-1509. 22 refs.

An isoparametric Hermite cubic element is developed for calculating compressible flows past complex aerofoils in two dimensions. A simple intermediate transformation is used to derive an isoparametric transform whose Jacobian is always non-zero and which attains very high accuracy on the boundary. Applications of the method and assessment of the error is illustrated by flow past a circular cylinder.

(Author)

**A79-54362** Is the Weis-Fogh principle exploitable in turbomachinery. S. B. Furber and J. E. F. Williams (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics*, vol. 94, Oct. 16, 1979, p. 519-540. 10 refs.

Weis-Fogh (1973) has discovered a remarkable new principle of aerodynamic lift from observations of the hovering motion of the chalcid wasp, where in the interaction of two wings, each wing acts as the starting vortex for the other. In his mathematical analysis of this effect, Lighthill (1973) has shown that the performance of the wing system is governed by parameters quite different from those determining the forces on conventionally operating isolated airfoils. In the present paper, a novel type of turbomachinery stage is proposed which exploits the Weis-Fogh principle in the interaction between rotor and stator for its normal operation. The stage has the unusual property that when started from rest it generates a pressure rise without shedding any vorticity into the fluid. It is argued that there may be a performance advantage for stages of this type. V.P.

**A79-54378** Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1979. 484 p. \$70.

Papers are presented on high-speed radar processing using CMOS/SOS technology, minimizing air launched cruise missile software life cycle costs, software engineering and standardization at the ESA, design of a highly reliable multiprocessor for space applications, and on the impact of parallel computers on the design of nonlinear flight controllers. Massively parallel information processing systems for space useage, and a comparative evaluation of RSL/REVS and PSL/PSA applied to a digital flight control system, are some of the topics mentioned. Attention is given to the architecture of both hierarchical multicomputer systems for satellite surveillance and data processing at ESA, and to on-board handling systems for ESA satellites, as well as to aerospace computer software.

C.F.W.

**A79-54380 #** High speed radar processing using CMOS/SOS technology. T. S. Kiesman (General Electric Co., Aircraft Equipment Div., Utica, N.Y.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 4-7. (AIAA 79-1901)

A LSI radar signal processor with size, weight, and power reduction that permits airborne processing with low speed data links is examined. The system requirements for this processor cover three processing areas of pulse compression, spectral analysis by means of Fast Fourier Transforms, and constant false alarm rate detection; each of these areas are described in detail. Attention is given to the LSI system development program, which is broken down into functions that are sufficiently independent in nature to permit parallel design efforts. The two layout options in the design of integrated circuits, such as PLINT and handcrafted layout, are also discussed.

C.F.W.

**A79-54383 #** Assessment of software development and maintenance costs due to retrofit of embedded avionics computer. M. S. Bridgman, E. F. Hitt, and T. R. Cork (Battelle Columbus Laboratories, Columbus, Ohio). In: Computers in Aerospace Con-

## A79-54389

ference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 17-22. (AIAA 79-1906)

A framework for evaluating the life cycle cost impacts of software alternatives for an embedded computer retrofit program is described. The objectives and approaches used in developing a model that combines the process and maintenance phase costs, and which considers language and implementation alternatives, as well as subsequent maintenance alternatives, is presented. The four steps in developing the model are: (1) define the characteristics of the decision environment, (2) identify the resources to be costed, (3) develop quantitative estimating relationships, which include establishing inclusion and exclusions, formulating assumptions and estimating specific factors, and (4) collect data and exercise the model. It is found that the procedure for estimating the effort required for the software development phase can account for characteristics such as benefits from existing software, choice of computer language, and use of structured programming.

C.F.W.

**A79-54389 # A case study of computer evolution in air defense, command and control, and air traffic control.** W. L. Martin (Hughes Aircraft Co., Fullerton, Calif.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 55-59. (AIAA 79-1914)

The paper presents a case study of the evolution of air defense, command and control, and air traffic control systems from the point of view of one systems engineering contractor. The development of the H-3118 computer is examined in detail with emphasis on hardware and software data. Attention is given to system applications and their progress, describing the functions of data processing in the Air Defense Ground Environment (ADGE). The block diagrams for present and future ADGE systems are given and some predictions of system architecture are made.

C.F.W.

**A79-54390 # Air traffic control and C/3/I - A comparative analysis.** E. H. Bersoff and J. Littley (CTEC, Inc., Falls Church, Va.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 71-76. 5 refs. (AIAA 79-1917)

The paper describes the function of the CCCI (Command, Control, Communications and Intelligence) and ATS systems and shows how their individual requirements are inherently related. Definitions are given for command and control, communications, CCC systems, a mission, surveillance, and intelligence. Attention is given to the comparison of the CCCI and ATC environments, emphasizing the responsibilities of those in command. The application of automation to these systems is described and the interaction between commanders and computers is noted.

C.F.W.

**A79-54392 # A multi microprocessor flight control system - Architectural concepts.** J. A. White, R. E. Pope (Honeywell Systems and Research Center, Minneapolis, Minn.), T. J. Molnar, J. E. May, and S. L. Maher (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 87-92. (AIAA 79-1925)

The paper describes the architectural concepts of a multimicroprocessor for flight control, emphasizing the design alternatives and the related tradeoffs. The areas examined include system partitioning, definition of functional units, interconnection alternatives, and hardware versus software, centering mainly on the processing aspects of the flight control system. The multimicroprocessor flight control system design is presented as an example of how a series of design decisions can be used to select alternatives which tailor a system to achieve specific goals. The design decisions, including partitioning, homogeneity, and sensor units are examined in detail. Finally the

design example is evaluated with respect to a set of design objectives which define the characteristics that an 'ideal' flight control system should possess.

C.F.W.

**A79-54412 # Flight tests of a microprocessor control system.** R. F. Stengel and G. E. Miller (Princeton University, Princeton, N.J.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 232-241. 23 refs. Contract No. N00014-78-C-0257. (AIAA 79-1962)

Flight experiments with a microprocessor control system have been conducted. The purposes of these tests were to provide information which will assist the development of flying qualities criteria for digital control systems and to investigate engineering characteristics of the research system. Four test pilots evaluated the effects of digital control system parameter variations on a research aircraft's longitudinal flying qualities during tracking and landing tasks. Critical ranges of sampling rate, quantization level, and time delay were identified as functions of the piloting tasks. In the subject aircraft, the limits for satisfactory control appear to be sampling rates of 4 to 10 per sec, control word lengths of 5 to 8 bits, and equivalent time delays of 50 to 250 msec, depending upon the task. Digital command and stability augmentation provides satisfactory flying qualities at lower sampling rates and resolution than with digital direct (unaugmented) command alone.

(Author)

**A79-54413 # Distributed microprocessors in avionics systems.** R. R. Bate (Texas Instruments, Inc., Lewisville, Tex.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 252-257. 6 refs. (AIAA 79-1965)

The advantages of multiple distributed processors in avionic systems are discussed along with the characteristics of the software which must be provided for these processors. Software construction is studied and need for software tools and testing aids to make possible the efficient and reliable construction of programs for these systems is outlined. It is noted that distributed processing systems provide access to the cheap, mass-produced microprocessors for increased flexibility and greater capability and can simplify technology insertion into avionic systems. New tools and techniques will be required because of the nature of distributed processing systems in addition to those for uniprocessor systems.

V.T.

**A79-54414 # The impact of parallel computers on the design of nonlinear flight controllers.** R. Travassos and H. Kaufman (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 258-263. 7 refs. Grant No. AF-AFOSR-77-3418. (AIAA 79-1966)

In this paper, a parallel computer architecture is proposed which utilizes three levels of parallelism to allow the implementation of modern nonlinear estimation and control algorithms. The proposed computer is a synchronous machine and uses a single instruction multiple data (SIMD) stream to efficiently implement these algorithms. The impact an advanced computer of this type might have on the design of nonlinear flight controllers is demonstrated for a F-8 aircraft, and the speedup due to parallelism is estimated. Results indicate that a significant reduction in the timing required for control computations may be possible if a parallel computer with this architecture were commercially available.

(Author)

**A79-54436 # Fixed byte and bit slice microcomputer survivability techniques.** J. Rogers (Grumman Aerospace Corp., Bethpage, N.Y.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 449-454. (AIAA 79-1964)

The paper describes techniques for achieving survivability to the transient upset phenomena, due to electromagnetic pulse (EMP) or nuclear radiation. Existing 8-bit fixed-byte micro-processors, in addition to 16-bit bit-slice architectures, are being used without considering nuclear radiation or EMP effects. A procedure is investigated, whereby if a logic upset level is encountered, the main memory is first tested and then rolled back to the last check point, which contains a previous state of the computer. A central processor unit (CPU) is then reloaded with this information, and reprocessing begins. The method also considers either double or triple redundant store in a time-dependent manner, so that least one or two good state captures has been achieved. The approach is adaptable for either fixed-byte or bit-slice microcomputer systems.

V.T.

**A79-54437 #** **Architecture of an intelligent cockpit monitoring system - SECURE.** R. T. Chien (Illinois, University, Urbana, Ill.). In: Computers in Aerospace Conference, 2nd, Los Angeles, Calif., October 22-24, 1979, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 455-457. U.S. Department of Transportation Contract No. OS-80020. (AIAA 79-1961)

The paper deals with the architecture of an 'intelligent' cockpit monitoring system SECURE (Safety Enhancement by Computer Reasoning). Context-based monitoring, qualitative modeling, knowledge-based interpretation, and automatic problem-solving concepts are introduced for a comprehensive design of the overall system. The present software system consists of three main parts: the simulator-model, the monitor module, and the automatic diagnosis module. The overall architecture of the system is determined by the natural organization of the knowledge base which is hierarchical.

V.T.

**A79-54473** **Design of supersonic airfoils by numerical optimization.** H. N. V. Dutt and A. K. Sreekanth (Indian Institute of Technology, Madras, India). *Computer Methods in Applied Mechanics and Engineering*, vol. 19, Sept. 1979, p. 417-427. 10 refs.

A practical procedure for the design of low-drag supersonic airfoils is demonstrated, using an optimization program based on a gradient algorithm coupled with an aerodynamic analysis program which incorporates a unitary compression/expansion formula for inviscid  $C_p$  distribution valid over a wide range of supersonic Mach numbers. Results are presented for low-drag nonlifting supersonic airfoils.

(Author)

## STAR ENTRIES

**N79-32153#** American Power Jet Co., Ridgefield, N.J.

**TECHNOLOGY TRENDS AND MAINTENANCE WORKLOAD REQUIREMENTS FOR THE A-7, F-4, AND F-14 AIRCRAFT**

**Preliminary Report, 1 Aug. 1977 - 1 Aug. 1978**

Thomas A. Blanco, George Chernowitz, James Ciccotti, and Alan Lee. May 1979 38 p refs  
(Contract N00123-77-C-0996)  
(AD-A070036: NPPRDC-TR-79-19) Avail: NTIS  
HC A03/MF A01 CSCL 01/3

Three major technology variables--system complexity, rate of technological change, and automation in diagnostics--were addressed to determine their significance in formulating a methodology for forecasting maintenance manpower requirements for new aircraft. These variables were analyzed separately for the A-7, F-4, and F-14 aircraft systems, as well as maintenance workload requirements. Conclusions are drawn from the effect of these variables on maintenance manhours per flying hour and distribution of workload among maintenance levels organizational, intermediate, and depot and work centers skills. Results indicate that system complexity, measured in terms of component reliability and density of functions number of parts per subsystem, and rate of testing the manpower requirements of a new aircraft system. Automation in diagnostic did not have significant effect on manpower requirements. The F-14 aircraft had a significantly different maintenance distribution by levels than the A-7 and F-4 models, the biggest shift being from organizational level down 20% from other aircraft to depot level up 71% from other aircraft. This was accompanied by a much greater use of commercial support 96% of total depot support than for other aircraft. GRA

**N79-32154#** General Accounting Office, Washington, D. C.

**CENTRALIZING AIR FORCE AIRCRAFT COMPONENT REPAIR IN THE FIELD CAN PROVIDE SIGNIFICANT SAVINGS**

28 Mar. 1979 69 p Prepared by the Comptroller General  
(PB-295320/6: LCD-79-409) Avail: NTIS HC A04/MF A01  
CSCL 01C

A report to the Subcommittee on Defense, House Committee on Appropriations which explains how the Air Force can use its field component repair resources more efficiently and effectively by centralizing such repair among units with common aircraft is presented. GRA

**N79-32156#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**AIRCRAFT VORTEX MARKING PROGRAM** Final Report

Michael F. Pompa 1 Oct. 1979 47 p refs  
(Contract NAS7-100)  
(NASA-CR-162299: JPL-Pub-79-77) Avail: NTIS  
HC A03/MF A01 CSCL 01A

A simple, reliable device for identifying atmospheric vortices, principally as generated by in-flight aircraft and with emphasis on the use of nonpolluting aerosols for marking by injection into such vortex (ices) is presented. The refractive index and droplet size were determined from an analysis of aerosol optical and transport properties as the most significant parameters in effecting vortex optimum light scattering (for visual sighting) and visual persistency of at least 300 sec. The analysis also showed that a steam-ejected tetraethylene glycol aerosol with droplet size near 1 micron and refractive index of approximately 1.45 could be a promising candidate for vortex marking. A marking aerosol was successfully generated with the steam-tetraethylene

glycol mixture from breadboard system hardware. A compact 25 lb/f thrust (nominal) H2O2 rocket chamber was the key component of the system which produced the required steam by catalytic decomposition of the supplied H2O2. M.M.M.

**N79-32157#** McDonnell Aircraft Co., St. Louis, Mo.

**MULTI-ELEMENT AIRFOIL VISCOUS-INVISCID INTERACTIONS** Final Report

L. W. Gross Hampton, Va. NASA 1979 28 p refs  
(Contract NAS1-15369)  
(NASA-CR-159125) Avail: NTIS HC A03/MF A01 CSCL  
01A

Subsonic viscous-inviscid interactions for multi-element airfoils are predicted by iterating between inviscid and viscous solutions until the performance coefficients converge. Inviscid flow is modelled by using distributed source-vortex singularities on configuration surface panels. Viscous effects are calculated by an existing laminar separation bubble model and a NASA-Lockheed boundary layer-wake method. Numerical formulations and example calculations are presented. Author

**N79-32158#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EFFECT OF OUTBOARD VERTICAL-FIN POSITION AND ORIENTATION ON THE LOW-SPEED AERODYNAMIC PERFORMANCE OF HIGHLY SWEPT WINGS**

Vicki S. Johnson and Paul L. Coe, Jr. Sep. 1979 30 p refs  
(NASA-TM-80142) Avail: NTIS HC A03/MF A01 CSCL  
01A

A theoretical study was conducted to determine the potential low-speed performance improvements which can be achieved by altering the position and orientation of the outboard vertical fins of low-aspect-ratio highly swept wings. Results show that the magnitude of the performance improvements is solely a function of the span-load distribution. Both the vertical-fin-chordwise position and toe angle provided effective means for adjusting the overall span-load distribution. A.R.H.

**N79-32159#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**REVIEW OF DESIGN AND OPERATIONAL CHARACTERISTICS OF THE 0.3-METER TRANSONIC CRYOGENIC TUNNEL**

Edward J. Ray, Charles L. Ladson, Jerry B. Adcock, Pierce L. Lawing, and Robert M. Hall Sep. 1979 56 p refs Presented at 1st Intern. Symp. on Cryogenic Wind Tunnels, Southampton, Engl., 3-5 Apr. 1979  
(NASA-TM-80123) Avail: NTIS HC A04/MF A01 CSCL  
01A

The past 6 years of operation with the NASA Langley 0.3 m transonic cryogenic tunnel (TCT) show that there are no insurmountable problems associated with cryogenic testing with gaseous nitrogen at transonic Mach numbers. The fundamentals of the concept were validated both analytically and experimentally and the 0.3 m TCT, with its unique Reynolds number capability, was used for a wide variety of aerodynamic tests. Techniques regarding real-gas effects were developed and cryogenic tunnel conditions can be set and maintained accurately. Cryogenic cooling by injecting liquid nitrogen directly into the tunnel circuit imposes no problems with temperature distribution or dynamic response characteristics. Experience with the 0.3 m TCT, indicates that there is a significant learning process associated with cryogenic, high Reynolds number testing. Many of the questions have already been answered; however, factors such as tunnel control, run logic, economics, instrumentation, and model technology present many new and challenging problems. A.R.H.

**N79-32163#** Boeing Commercial Airplane Co., Seattle, Wash. **A PROGRAM TO COMPUTE THREE-DIMENSIONAL SUBSONIC UNSTEADY AERODYNAMIC CHARACTERISTICS USING THE DOUBLET LATTICE METHOD, L216 (DUBFLX). VOLUME 1: ENGINEERING AND USAGE** Topical Report, May 1975 - May 1977

M. Richard and B. A. Harrison Washington NASA Oct. 1979 123 p refs  
(Contract NAS1-13918)  
(NASA-CR-2849; D6-44458-Vol-1) Avail: NTIS

HC A06/MF A01 CSCL 01A

The program input presented consists of configuration geometry, aerodynamic parameters, and modal data; output includes element geometry, pressure difference distributions, integrated aerodynamic coefficients, stability derivatives, generalized aerodynamic forces, and aerodynamic influence coefficient matrices. Optionally, modal data may be input on magnetic file (tape or disk), and certain geometric and aerodynamic output may be saved for subsequent use. M.M.M.

**N79-32164#** Boeing Commercial Airplane Co., Seattle, Wash. **MODAL INTERPOLATION PROGRAM, L215 (INTERP). VOLUME 1: ENGINEERING AND USAGE** Topical Report, May 1975 - May 1977

R. I. Kroll and M. Y. Hirayama Washington NASA Oct. 1979 121 p refs  
(Contract NAS1-13918)  
(NASA-CR-2847; D6-44456-Vol-1) Avail: NTIS

HC A06/MF A01 CSCL 01A

The usage of the Modal Interpolation Program L215 (INTERP) is described. The program uses modal data to form sets of arrays containing interpolation coefficients. The interpolation arrays can then be used to determine displacements at various aerodynamic surface and surface slopes that are parallel and perpendicular to the freestream direction. Five different interpolation methods are available. A description of the data manipulation and the interpolation methods is presented. G.Y.

**N79-32166#** University of Southern California, Los Angeles. Dept. of Aerospace Engineering.

**THE OBLIQUE WING AS A LIFTING-LINE PROBLEM IN TRANSONIC FLOW**

H. K. Cheng and S. Y. Meng May 1979 114 p  
(Contract N00014-75-C-0520; NR Proj. 061-192)  
(AD-A070232; USCAE-53-4514-1541; USCAE-136) Avail: NTIS

HC A06/MF A01 CSCL 20/4

A transonic-flow theory of thin oblique wing of high aspect ratio is presented, which permits a delineation of the influence of wing sweep, centerline curvature, and other three-dimensional (3-D) effects on the nonlinear mixed flow in the framework of an asymptotic theory. The component flow near the wing section is basically plane (two-dimensional) but nonlinear and mixed, being governed by equations consistent with the transonic small-disturbance approximation. The work analyzes 3-D corrections to this nonlinear problem and matching its solutions to that of an outer flow. In the (parameter) domain of interest, the outer solutions correspond to a high subsonic, or a linear sonic, outer flow, representable by a Prandtl-Glauert solution involving a swept (or curved) lifting line in the leading approximation. A procedure based on a line relaxation method for solving numerically the reduced inner problem is described; solutions with high subcritical, as well as slightly supercritical, component flows are demonstrated. Comparison with corresponding numerical solutions based on full-potential equations for oblique elliptic wing shows encouraging agreement. GRA

**N79-32172#** Calspan Advanced Technology Center, Buffalo, N. Y. **THEORETICAL STUDIES OF THREE DIMENSIONAL TRANSONIC FLOW THROUGH A COMPRESSOR BLADE ROW** Annual Technical Report, 1 Apr. 1978 - 31 Mar. 1979

W. J. Rae 31 Mar. 1979 12 p refs  
(Contract F49620-78-C-0057)  
(AD-A071020; CALSPAN-6275-A-1; AFOSR-79-0805TR) Avail: NTIS

HC A02/MF A01 CSCL 20/4

Three dimensional flow effects play an important role in the performance of axial-flow fans and compressors that operate at transonic speeds. The coupling between transonic and three dimensional effects limits the applicability of the two dimensional analysis methods that have been in use for some years. The present research program was undertaken with the aim of extending these numerical techniques, so as to handle more fully the nonlinearity of the problem. Thus, heavily loaded blades with large turning angles are to be considered, and the simplifications of small-disturbance theory (such as satisfaction of boundary conditions on mean-chord surfaces, neglect of trailing vortex-sheet deformation) will not be used. GRA

**N79-32174#** Analytical Methods, Inc., Bellevue, Wash. **HELICOPTER FLOW FIELD ANALYSIS** Final Report, Apr. 1977 - Sep. 1978

David R. Clark, Frank A. Dvorak, Brian Maskew, T. Michael Summa, and Frank A. Woodward Apr. 1979 80 p refs  
(Contract DAAJ02-77-C-0028)  
(AD-A069542; USARTL-TR-79-4) Avail: NTIS

HC A05/MF A01 CSCL 20/4

A computer program has been developed which allows the flow around general aircraft configurations to be modeled, including the effects of regions of separated flow. The program, although developed specifically to handle the regions of separated flow associated with the typically bluff helicopter airframes, retains the capability to model the more slender shapes associated with fixed-wing aircraft. The flow around the specified configuration is calculated iteratively, the first step being the solution of the basic potential flow. This is followed by the definition of the potential flow streamlines over the surface, the calculation of boundary layer growth along the streamlines, the identification of the separated flow region and the eventual recalculations of the potential flow, including the effects of boundary layer growth and separated flow. The iterations between potential and viscous flow may be repeated as often as desired. During its development, the program has been exercised on a number of helicopter and aircraft configurations. This experience has shown that the program can be used to model the flow about the involved shapes typical of the new generation of rotocraft now going into service without any increase in difficulty, either in preparing the input data or in executing the solution, when compared with earlier purely potential flow solutions. GRA

**N79-32175#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

**WINDTUNNEL MEASUREMENTS ON THE INTERFERENCE BETWEEN A JET AND A WING LOCATED OUTSIDE THE JET. PART 1: TEXT, TABLES, AND FIGURES**

Y. G. Kho 9 Feb. 1979 93 p refs  
(Contract NIVR-1761)

(NLR-TR-77009-U) Avail: NTIS HC A05/MF A01

A windtunnel investigation on the interference between a jet and a wing half model located outside the jet is described. Pressure distributions on the wing and lift coefficients calculated from them were used for evaluation of a method for the prediction of interference effects between jets and parts of airframes. A reduction of lift is found due to the jet below the wing, whereas the jet above the wing induces more lift, sometimes even leading to early separation and stall. Also for comparison with calculated cross sectional jet areas, contours of the jet were estimated at two stations behind the nozzle exit. Author (ESA)

**N79-32176#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

**CALCULATION OF THE FLOW AROUND A SWEPT WING, TAKING INTO ACCOUNT THE EFFECT OF THE THREE-DIMENSIONAL BOUNDARY LAYER. PART 2: WING WITH LAMINAR BOUNDARY LAYER ON THE LOWER SURFACE**  
B. vandenBerg, W. J. Piers, and E. deBoer 9 Feb. 1979 26 p refs

(Contract NIVR-1737)

(NLR-TR-77066-U) Avail: NTIS HC A03/MF A01

The attached flow around a swept wing was calculated with allowance for the effects of boundary layer and wake. Calculations

for a swept wing with a laminar lower surface boundary layer were compared with experimental data. The comparison reveals that the viscous lift loss is less well predicted than for the case of a swept wing with a turbulent boundary on the upper and lower surface due to an existing uncertainty about the state of the lower surface boundary layer near the trailing edge.

Author (ESA)

**N79-32177#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

**EXPERIMENTAL INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A WING IN A JET FLOW**

T. Zandbergen, R. A. Maarsingh, and C. J. J. Joosen 9 Feb. 1979 75 p refs

(Contract NIVR-1768)

(NLR-TR-77081-U) Avail: NTIS HC A04/MF A01

To test the qualities of the theoretical models used in two different calculation methods, pressure distributions were measured on a simple half-model wing-in-jet combination. The position of the jets relative to the wing was varied, mainly in a plane perpendicular-to-the-span. Jet velocities of one, two, and three times the tunnel velocity were used. The wing model was used with and without a small, full-span auxiliary airfoil flap deflected at 30 deg. Results indicate that data from this test setup are appropriate for evaluating methods for calculating the distributed and total (integrated) lift on wings, and that a very complete picture of jet induced effects can be obtained.

Author (ESA)

**N79-32178#** Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.

**AERODYNAMIC DATA FOR THREE SUPERCRITICAL AIRFOILS: RAE(NPL) 9515 AND 9530, AND RAE 9550. PARTS 1 AND 2**

J. L. Fuller London Aeron. Res. Council 1978 153 p refs Previously announced as ARC-R/M-36198 and ARC-R/M-36262 (RAE-TR-74082 and RAE-TR-75068)

(ARC-R/M-3820; BR67756; ISBN-0-11-471153-4) Avail: NTIS HC A08/MF A01; HMSO £ 12

The experimentally determined aerodynamic characteristics of two 10.5% thick supercritical airflow sections, (RAE(NPL) 9515 and 9530) are compared, over the Mach number range 0.3 to 0.88 and with angles of incidence from -0.82 to 14. The corresponding results for RAE 9550, a 12.2% thick supercritical airfoil derived from an NLR shockless lifting airfoil, from tests over the Mach number range 0.4 to 0.82 and with angles of incidence from 1 deg to 11 deg are given. The results are compared with theory and with the limited published results for an airfoil of a similar type.

Author (ESA)

**N79-32179#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

**WIND TUNNEL TESTS ON CAMBERED WINGS OF MILD GOTHIC PLANFORM. PART 1: FURTHER LOW SPEED TESTS. PART 2: TRANSONIC TESTS**

P. J. Butterworth and P. Lee London Aeron. Res. Council Feb. 1978 113 p refs Previously announced as ARC-R/M-37556 and ARC-R/M-37523 (RAE-TR-77018 and RAE-TR-77006)

(ARC-R/M-3827; BR67755; ISBN-0-11-471160-7) Avail: NTIS HC A06/MF A01; HMSO £ 9

The low-speed, longitudinal characteristics were investigated for five cambered and two symmetric wings of mild gothic planform. These were designed, using a linear theory, for attached leading-edge flow at the low values of lift coefficient typical of the cruise of slender aircraft. The purpose of the investigation was to check that cambered wings designed in this way can produce, at the higher lift coefficients appropriate to take-off, substantial reductions in drag relative to a symmetric wing. The wings all had thickness/chord ratios of 0.09 or 0.004. The cambered wings were designed to have attached leading-edge flow at various values of lift coefficient and position of the center of pressure. The force-measurement and flow-visualization tests show that the design criteria were almost achieved, although inboard separations were observed under transition-free flow

conditions. However, roughness bands applied near the leading edges suppressed these separations and the force results which are analyzed in detail were all obtained with boundary-layer transition fixed.

Author (ESA)

**N79-32180#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Fluid Dynamics.

**THE DESIGN AND AERODYNAMIC CHARACTERISTICS OF AN 18% THICK SHOCK-FREE AIRFOIL (NLR 7501)**

J. A. vanEgmond and D. Rozendal 5 Jun. 1978 27 p refs Presented at DGLR/GARTEUR 6 Symp. on Transonic Configurations, Bad Harzburg, West Germany, 13-15 Jun. 1978 (NLR-MP-78016-U) Avail: NTIS HC A03/MF A01

The design and experimental verification of a thick (18%) shock free airfoil is described. The design was performed using the hodograph theory for transonic airfoil design. The airfoil was experimentally investigated in a pilot tunnel. Off-design characteristics compare well with thinner airfoils. However, drag levels are much higher, mainly as a result of boundary layer separation at the trailing edge.

Author (ESA)

**N79-32181#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Scientific Services.

**MULTI-ELEMENT AIRFOIL DESIGN BY OPTIMIZATION**

T. E. Labrujere 19 Jun. 1978 10 p refs Presented at 11th ICAS Congr., Lisbon, Sep. 1978

(NLR-TR-78135-U) Avail: NTIS HC A02/MF A01

A method is presented for the design of multi-element airfoils in incompressible flow such that a priori specified aerodynamic and geometric requirements are fulfilled approximately. An object function is formed by summing the squared weighted deviations from the prescribed pressure distribution, zero normal velocity, and geometric conditions. Minimizing the object function results in the simultaneous determination for the shape of the airfoil and the real pressure distribution.

Author (ESA)

**N79-32183#** Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

**FACTOR OF SAFETY - USAF DESIGN PRACTICE Final Report, Jan. - Sep. 1977**

George E. Muller and Clement J. Schmid Apr. 1978 104 p refs Presented at the 45th Meeting of the Structures and Mater. Panel of AGARD, Voss Norway, 26 Sep. 1977 (AF Proj. 2401)

(AD-A070237; FFDL-TR-78-8) Avail: NTIS HC A06/MF A01 CSCL 01/2

A review of the historical development of the 1.5 structural factor of safety for airplanes, the 1.4 factor for manned space vehicles, and the 1.25 factor for missiles is presented from an Air Force perspective. Several variations and experimental applications of the factor of safety design concept and reliability based design concepts are also reviewed to show their interaction. Although not without criticism, the factor of safety design concept has become an almost universally accepted measure of flight safety. There is, however, a tendency among engineers to both challenge the continued application of factors of safety for efficient airframe design, and yet to avoid any changes that would challenge the confidence of future designs. The use of reliability based concepts will probably increase but their application to airframe design may be limited. The factor of safety still covers many contingencies and it appears at this time there will be a continuing need for some factor.

GRA

**N79-32185#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**COCKPIT DISPLAYS OF TRAFFIC INFORMATION: AIRLINE PILOTS OPINIONS ABOUT CONTENT, SYMBOLIC, AND FORMAT**

Sandra G. Hart (Tufts Univ., Medford, Mass.) and Thomas E. Wempe Aug. 1979 54 p refs (NASA-TM-78601; A-7884) Avail: NTIS HC A04/MF A01 CSCL 17G

A number of candidate computer-generated cockpit displays of traffic information (CDTI) displays and display options were

simulated statically and were shown to 23 airline pilots who were asked to respond to more than 250 questions about them. The pilots indicated that the amount and complexity of navigation information displayed should increase with altitude and map scale. Terrain information should appear automatically if a pilot's own aircraft descends below the minimum safe altitude and should include only those obstruction within 2,000 ft or less. Few pilots that weather information should be displayed on a CDTI, but if it was, it should be at pilot request only. A chevron-shaped symbol, located so that the majority of the map area was ahead was preferred. The position, altitude, ground speed, ground track, weight class, and flightpath history of other aircraft should be presented graphically by coding the shape of the symbol for other aircraft or presented digitally in data tags displayed at pilot request. All pilots thought that color coding was necessary to recognize different categories of information quickly and accurately. The majority of pilots felt that a CDTI would provide useful information even though its presence might increase their workload somewhat particularly during its introductory stages.

A.R.H.

**N79-32186#** Melbourne Univ., Carlton (Australia). Coll. of Optometry.

**RECOGNITION OF THE AIRCRAFT NAVIGATION LIGHT COLOUR CODE**

K. J. Bowman and B. L. Cole Sep. 1979 69 p refs

Avail: NTIS HC A04/MF A01

The sources of visual information for determining the risk of collision were examined and it was found that the navigation light system can serve as a crude screening method enabling categorization of intruder aircraft into 'potential threat' and 'no threat' categories. It was noted that the minimum intensities for navigation signals afford only a limited visual range which might be further reduced by high intensity presence lights. However, it was also found that the fixity of bearing criterion has a number of shortcomings: it is invalid when either aircraft is changing course or speed and it may require a long pick-up range and lengthy periods of unwavering observation of the relative position of the intruder aircraft. An experiment is described which shows that observers with normal color vision are able to determine aircraft aspect and relative heading from the navigation light code with a moderately high degree of reliability. The reliability of judgement is decreased by higher intensity presence lights especially when they are located close to the navigation lights.

R.E.S.

**N79-32191#** National Aerospace Lab., Amsterdam (Netherlands). Scientific Services Div.

**COMPARISON OF SOME METHODS TO DETERMINE THE DELAYS OF LANDING AIRCRAFT WITH RESPECT TO RUNWAY CAPACITY**

M. vandenWilt 3 Mar. 1979 34 p refs  
(NLR-MP-77028-U) Avail: NTIS HC A03/MF A01

The capacity of runways in use for landing aircraft can become the chief bottleneck as regards the capacity of airports. This runway capacity can result in long queues of aircraft waiting to land, which in turn results in unacceptable delays. Two analytic methods for determining these delays are described and the results are compared. The two methods differ in their modeling of the queuing system, which results in an optimistic and a pessimistic estimate of the delays. Finally, a model for Monte Carlo simulations is briefly described. The uncertainties in results obtained from this simulation model are estimated. Author (ESA)

**N79-32192#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

**WIND SHEAR DURING APPROACH: AN INVESTIGATION INTO THE INFLUENCE OF A TOWER MEASURED WIND ENVIRONMENT ON THE SYMMETRIC MOTIONS OF A SIMULATED AIRCRAFT DURING AN AUTOMATIC APPROACH**

J. Schurring 10 Apr. 1979 40 p refs  
(Contracts RB-RLD-76008; RB-RLD-77007)  
(NLR-TR-77078-U) Avail: NTIS HC A03/MF A01

Measured wind profiles from the Royal Netherlands Meteorological Institute 200 m meteorological tower at Cabauw were used to estimate wind shear effects on the symmetric motions of an approaching aircraft. Wind profiles as well as an automatically approaching DC-9 aircraft were simulated on an electronic analog computer. The study shows that requirements for autopilots, etc., specifying only mean shear values, like the 8 km/100 ft concept (FAA), are not adequate. Simulation results and measured wind data for the year 1973 were combined to obtain statistical information on the chance of exceeding a certain deviation from the glide path during an approach. The results indicate that relatively large deviations in the aircraft flight path are related to night stable meteorological conditions, with low wind speeds at height of 10 m, in particular from the east or south. The largest deviations produced by the Cabauw wind profiles for 1973 did not exceed the coverage of a normal I.L.S. glide path indicator. Severe storms did not present hazardous situations in terms of vertical wind shear.

Author (ESA)

**N79-32193#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

**NAVAIR CALIBRATION EVALUATION WITH A COMPUTER CONTROLLED AVIONICS DATA ACQUISITION SYSTEM**

F. J. Abbink and R. Krijn 24 Aug. 1978 41 p refs Presented at 9th AIDS Symp. of the Deut. Studiengruppe fuer Flugdatensys. (DSF), Friedrichshafen, West Germany, 26-27 Sep. 1978  
(NLR-MP-78030-U) Avail: NTIS HC A03/MF A01

To evaluate the applicability and accuracy of multi-distance measuring equipment (DME) positioning, a computer-controlled avionics-data acquisition system (CADAS) was developed. CADAS adaptively tunes the DME interrogator and acquires selected, time tagged data for recording on magnetic tape. With CADAS several multi-DME evaluation flights were executed. The results on the position accuracy and coverage of the multi-DME system are presented. This system was also used as a reference for the calibration of an Inertial Sensor System (ISS), VHF omnidirectional radio range (VOR) navigation beacons, and an air traffic control (ATC) radar. The results of these ISS calibration flights are presented. The measured errors are compared with the computed error variance obtained by the application of a covariance model and ISS component error variances. Furthermore, the VOR calibration results for various orbital and radial flights on standard and Doppler VORs are presented. The influence of the position where the VOR is calibrated as well as the possibility of calibrating multiple VORs on the same flight are investigated. Results of ATC radar power density measurement flights at various altitudes and flight tracks are given.

Author (ESA)

**N79-32194#** Royal Aircraft Establishment, Farnborough (England).

**TRIALS OF THE DOPPLER MICROWAVE LANDING SYSTEM AT LONDON (GATWICK) AIRPORT, AUGUST 1977**

P. L. Gibson London Aug. 1977 83 p refs Sponsored by Min. of Defence.

(RAE-TR-78124; BR66981) Avail: NTIS HC A05/MF A01

The trials of the Doppler microwave landing system (DMLS) at Gatwick formed part of a series conducted at operational airports to collect data for the ICAO evaluation program. Typical data collected from the trials at Gatwick and analysis of the results show that DMLS met the performance requirements at this airport for line of sight propagation paths. No specific technique related effects were seen and the results are regarded as typical of C band MLS performance at this airport.

Author (ESA)

**N79-32195#** Royal Aircraft Establishment, Farnborough (England).

**TRIALS OF THE DOPPLER MICROWAVE LANDING SYSTEM AT MANCHESTER INTERNATIONAL AIRPORT, OCTOBER/NOVEMBER 1977**

D. Walker London 1977 130 p refs Sponsored by Min. of Defence

(RAE-TR-78144; BR67351) Avail: NTIS HC A07/MF A01

Tests performed at Manchester to determine the multipath environment are described. High levels of azimuth system multipath were found close to the runway threshold but azimuth systems with as small an aperture as 20 wavelengths (1.2 m) gave the equivalent of ILS Category 3 accuracy. No isolated sources of elevation multipath were found and a 39 wavelength aperture system (2.3 m) gave the equivalent of ILS Category 3 accuracy for 3 deg approaches. The coverage requirement of 20 n mile range and + or - 40 deg azimuth was achieved at heights sufficient to give clear line of sight, but at elevation angles below about 1.5 deg shadowing caused signal loss and large errors. Autolands were demonstrated using the 54 wavelength aperture systems. No specifically technique related effects were seen and the results are regarded as representative of typical C-band MLS performance. Author (ESA)

**N79-32197#** Rockwell International Corp., Los Angeles, Calif.  
**HIMAT STRUCTURAL DEVELOPMENT DESIGN METHODOLOGY**

M. A. Price Oct. 1979 234 p refs  
(Contract NAS4-25600)  
(NASA-CR-144886) Avail: NTIS HC A11/MF A01 CSCL 01C

In order to improve aerodynamic performance, a twist criterion was used to design the canard and wing lifting surfaces of two graphite-epoxy research aircraft. To meet that twist criterion, the lifting surfaces were tailored using graphite-epoxy tape. The outer surface of the aircraft is essentially constructed of 95 percent graphite epoxy materials. The analytical tools and methodology used to design those lifting surfaces are described. One aircraft was subjected to an 8g ground test in order to verify structural integrity and to determine how well the desired twist was achieved. Test results are presented and the reductions of both flight and ground strain test gages and their associated stresses are discussed. A.R.H.

**N79-32198#** Systems Technology, Inc., Mountain View, Calif.  
**POWERED-LIFT AIRCRAFT HANDLING QUALITIES IN THE PRESENCE OF NATURALLY-OCcurring AND COMPUTER-GENERATED ATMOSPHERIC DISTURBANCES**

Final Report, 11 May 1977 - 26 Apr. 1979

Wayne F. Jewell, Warren F. Clement, Thomas C. West (FAA, Washington, D. C.), and S. R. M. Sinclair May 1979 86 p refs Prepared in cooperation with National Aeronautical Establishment, Ottawa (Ontario)  
(Contract DOT-FA77WA-3936)  
(AD-A072118; FAA-RD-79-59; STI-TR-1099-3) Avail: NTIS HC A05/MF A01 CSCL 01/2

The handling quality assessments obtained in the airborne and ground-based simulators were similar, but wind shear was responsible for more of the differences than turbulence. The comparison of the handling quality assessments and selected measures of combined pilot-vehicle performance obtained with the naturally occurring and computer generated turbulences demonstrate that the Dryden model can yield optimistic ratings of airplane handling qualities and an optimistic estimate of combined pilot-vehicle performance degradation in turbulent landing conditions. M.M.M.

**N79-32199#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.  
**PRELIMINARY AIRWORTHINESS EVALUATION CH-47C WITH FIBERGLASS ROTOR BLADES WITH T55-L-712 ENGINES** Final Report

Sherwood C. Spring, John R. Niemann, and Grady W. Wilson Apr. 1979 79 p  
(AD-A069891; USAEFA-77-31) Avail: NTIS HC A05/MF A01 CSCL 01/3

A Preliminary Army Evaluation of a CH-47C helicopter equipped with Fiberglass rotor blades was flown from 31 October through 7 November 1978. A total of 22 hours, 13 of which were productive, was required. Tests were conducted at the Boeing Vertol test facility at Wilmington, Delaware. Fiberglass

rotor blades at a rotor speed of 225 rpm have improved hover performance in terms of decreased power required when compared to metal blades at the operating rotor speeds of 235 and 245 rpm. There is an improvement in level flight performance in terms of a reduction in power required between fiberglass blades at a rotor speed of 225 rpm compared to metal blades at a rotor speed of 245 rpm. Handling qualities, for all conditions tested, were essentially the same as with metal rotor blades and are satisfactory. Five shortcomings were identified, only two of which were related to the fiberglass rotor blades. The fiberglass blade related shortcomings were (1) the high six-per-rotor-revolution (6/rev) (22.5 Hz) vibration levels in the vicinity of the cargo hatch and ramp area at light gross weight and airspeeds of 100 knots calibrated airspeed (KCAS) and above; and (2) high vibration levels (3 and 6/rev) throughout the aircraft at airspeeds of 140 KCAS and above. The other shortcomings are standard CH-47C problems that remain unchanged with fiberglass rotor blades and were associated with excessive cabin noise levels, lack of adequate intercom/radio audio gain when using earplugs and poor power management characteristics. GRA

**N79-32200#** Boeing Aerospace Co., Seattle, Wash.  
**THE TRANSONIC OSCILLATING FLAP Final Report, Apr. Sep. 1978**

Wilson C. Chin May 1979 21 p refs  
(Contract N00014-78-C-0349)  
(AD-A070022; D180-2530-1) Avail: NTIS HC A02/MF A01 CSCL 20/4

Numerical experiments for the unsteady transonic flow past a symmetric airfoil with an oscillating flap in free air are carried out for a range of supercritical Mach numbers and reduced frequencies using two newly devised computational schemes. The inviscid results, unhampered by the complicating effects of wind tunnel wall interference and shockwave and boundary layer interaction, evaluate the extent to which the unsteady loading responds linearly to changes in flap deflection and also the dependence of shock excursion amplitude and net unsteady lift and moment coefficients on oscillation frequency. The main conclusions are discussed in light of recent experimental findings. GRA

**N79-32201#** Battelle Columbus Labs., Ohio.  
**COLLECTED ENGINEERING DATA SHEETS, AIR FORCE DATA SHEET PROGRAM** Final Report, Apr. 1965 - Sep. 1978

Omar Deel Wright-Patterson AFB AFML Dec. 1978 524 p  
(Contract F33615-77-C-5009; AF Proj. 7381)  
(AD-A070665; AFML-TR-78-179) Avail: NTIS HC A22/MF A01 CSCL 11/6

The major objectives of this program were to evaluate newly developed materials of interest to the Air Force for potential airframe structural usage, and to provide 'data sheet' type presentations of engineering data for these materials. This report presents a collection of all of the data sheets generated to date on the Air Data Sheet Program. GRA

**N79-32202#** Boeing Aerospace Co., Seattle, Wash.  
**TRANSONIC WING REDESIGN USING A GENERALIZED FICTITIOUS GAS METHOD** Final Report, Oct. 1978 - May 1979

N. Yu and P. E. Rubbert May 1979 35 p refs  
(Contract N00014-78-C-0349)  
(AD-A070013; D-180-25309-1) Avail: NTIS HC A03/MF A01 CSCL 20/4

A numerical method for transonic shock-free or nearly shock-free airfoil and wing redesign based on the full potential equation is presented. The method utilizes a generalized fictitious gas approach wherein a variety of parameters controlling the character of the fictitious gas laws are introduced to provide a degree of control over the redesigned upper surface geometry and the pressure distribution of the redesigned shape. Results for a redesigned advanced airfoil as well as a three-dimensional wing are illustrated. Significantly improved aerodynamic characteristics are achieved through the present redesigned technique. GRA

**N79-32203#** Southwest Research Inst., San Antonio, Tex.  
**EXPERIMENTAL METHODS FOR AIRCRAFT DESIGN**  
**QUALIFICATIONS IN AN EXPLDING WARHEAD ENVIRONMENT** Final Report, Jul. 1977 - Oct. 1978  
E. D. Esparza Feb. 1979 72 p  
(Contract DAAK11-77-C-0043)  
(AD-A070381: AFFDL-TR-79-3008) Avail: NTIS  
HC A04/MF A01 CSCL 01/3

An experimental program was performed to investigate the effect of high-velocity fragments alone and coupled with a blast pressure to determine whether accurate simulation testing of aircraft fuel tanks in a near-miss exploding warhead environment must include the blast threat. A series of tests was conducted to synchronize the fragments and blast pressure loading. Experiments were then conducted using a simulated fuel tank which included replaceable front and rear walls. The fuel tank, empty and full of water, was tested with five steel rectangular prism fragments alone, and the combination of the same fragments with a blast pressure wave of similar magnitude and duration as would be generated by an exploding warhead. Four types of aluminum front panels were tested using two types of aluminum and two thicknesses of each. The rear panel used on the full tank tests was the same for all these tests. The report presents the complete experimental program, a description of the test facilities, the simulation techniques and the instrumentation used in the program. Structural damage of the test panels are depicted by photographs of each panel. The results indicate that the addition of blast pressure can definitely enhance the fragment damage to the panels, particularly with an empty fuel tank. GRA

**N79-32204#** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.  
**QUALIFICATION TESTS FOR HELICOPTERS TO BE USED ON BOARD SHIPS**  
T. Hoekstra, R. Fang, C. Leijnse, and L. T. Renirie 17 Aug. 1978 21 p Presented at Europort Naval Conf., Amsterdam, 14-17 Nov. 1978  
(NLR-MP-78032-U) Avail: NTIS HC A02/MF A01

Although helicopter manufacturers usually define limits for the safe operation of a helicopter, they generally apply to a rigid platform situation only. For operations involving ships, additional limitations must be observed. The requirement for the development of adapted operation procedures for helicopters and the determination of new limitations to ensure optimum use and adequate safety are discussed. The relevant test procedure is described. It is shown that, despite certain difficulties related to the kinds of tests, the desired objective can be attained.

Author (ESA)

**N79-32205\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.  
**LOW-COST INERTIAL NAVIGATION FOR MODERATE-g MISSIONS**  
Shmuel Merhav Sep. 1979 61 p refs  
(NASA-TM-78611: A-7920) Avail: NTIS HC A04/MF A01 CSCL 01D

A low cost inertial navigation system (INS) concept is described for flight missions characterized by moderate accelerations and limited attitude variations. These missions involve general aviation aircraft, helicopters, or remotely piloted vehicles. The significance of the moderate acceleration and limited attitude is reviewed with respect to platform mechanization and instrumentation. A hybrid mechanization, partially gimbaled and partially strapdown, is presented. The INS is implemented by an unbalanced two axis gimbal system and controlled by a two degree of freedom gyro. The INS provides locally level two axis acceleration information along with pitch and roll measurements. Heading information is provided by a second gyro mounted in the inner gimbal. The system error model is equivalent to that of a conventional platform with a tilt error determined by the integral of the gyro drift rate and an equivalent accelerometer type errors are also cancelled. Rapid gyro-compassing, implemented with opened gimbal control loops, and a strapdown procedure provides calibration of gyro drift rate biases. A.W.H.

**N79-32206#** Arinc Research Corp., Annapolis, Md.  
**AVIONICS COST DEVELOPMENT FOR USE OF LORAN-C**

**NAVIGATION SYSTEMS BY LOW PERFORMANCE GENERAL-AVIATION AIRCRAFT** Final Report  
S. H. Kowalski Apr. 1979 26 p refs  
(Contract DOT-FA76WA-3788)  
(AD-A068268: Rept-1326-01-8-1906) Avail: NTIS  
HC A03/MF A01 CSCL 17/7

This avionics cost study of the Long-Range Navigation (LORAN-C) system used by low-performance general-aviation aircraft, performed for the Federal Aviation Administration (FAA) Office of Systems Engineering Management (OSEM), was based on a uniform approach to cost estimating with the assistance of a pricing model. The system evaluated is the Teledyne TDL-711 LORAN Micro-Navigator, with appropriate design and packaging modifications to meet the less stringent environmental and packaging requirements of general aviation. The LORAN-C system in its airborne configuration requires a receiver, a control and display unit, and an antenna with a built-in coupler. The expected costs of the avionics required by single and light-twin-engine aircraft were developed by using a parametric cost-estimating model. These costs, shown in Table S-1, are in 1977 dollars, without inflation, and are based on annual production quantities of 1,000 units. Development costs were amortized over a 3,000 - unit production quantity. The 1977 dollars were used to facilitate comparison with other cost results of alternative navigation systems previously evaluated by ARINC Research for the FAA. GRA

**N79-32207#** Army Missile Research and Development Command, Redstone Arsenal, Ala. Guidance and Control Directorate.

**FLIGHT TEST RESULTS OF A VIRTUAL IMAGE, PANTOGRAPH MOUNTED, CONTROL AND DISPLAY STATION**  
Michael C. Pitruzzello 23 Feb. 1979 19 p  
(AD-A070290: DRDMD-T-79-33) Avail: NTIS  
HC A02/MF A01 CSCL 19/5

A growing number of US Army programs requires target detection and identification at long stand-off-ranges from airborne (helicopter) platforms. One method that is currently being pursued to meet this requirement is to provide the helicopter gunner with a precision stabilized optical or electro-optical sighting system. Unfortunately, the required optical magnification requires a small angular field-of-view. This can result in excessive target search times during which the helicopter may be vulnerable to enemy fire. Author (GRA)

**N79-32208#** National Oceanic and Atmospheric Administration, Miami, Fla. Facilities Research Center.

**RECORD KEEPING ON AIRCRAFT INSTRUMENTS**  
Heinz H. Grote Dec. 1978 79 p  
(PB-295698/5: NOAA-TM-ERL-RFC-2: NOAA-79041204)  
Avail: NTIS HC A05/MF A01 CSCL 01D

The record keeping process for aircraft instruments and their use, calibration, and repair is described. Computer techniques are discussed and sample computer programs are appended. GRA

**N79-32209** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

**AN INVESTIGATION OF FLAME STABILITY IN A COAXIAL DUMP COMBUSTOR** Ph.D. Thesis  
Edward Thomas Curran 1979 235 p  
Avail: Univ. Microfilms Order No. 7920915

An experimental investigation of the flame stability characteristics of a coaxial dump combustion chamber was made. A derived correlating parameter was used to obtain successful correlations. The dominant variable in flame stability was the inlet temperature; the subsidiary variables were the step height, inlet pressure, and velocity. The effect of velocity on the lean extinction limit was very small. With JP-4 fuel the existence of complete stability loops was demonstrated by operating at very low combustor pressures. Tests were performed using a transparent quartz combustor; it was observed that the combustion process was an oscillatory phenomenon with the reaction zone moving rapidly to and fro along the combustor. Dissert. Abstr.

**N79-32210\*** Joint Inst. for Advancement of Flight Sciences, Hampton, Va.  
**ACOUSTIC ANALYSIS OF THE PROPFAN Final Report**  
 F. Farassat (George Washington Univ.) and G. P. Succi (MIT) 1979 42 p refs  
 (Contract NAS1-15154; Grant NSG-1474)  
 (NASA-CR-162312) Avail: NTIS HC A03/MF A01 CSCL 21E

A review of propeller noise prediction technology is presented. Two methods for the prediction of the noise from conventional and advanced propellers in forward flight are described. These methods are based on different time domain formulations. Brief descriptions of the computer algorithms based on these formulations are given. The output of the programs (the acoustic pressure signature) was Fourier analyzed to get the acoustic pressure spectrum. The main difference between the two programs is that one can handle propellers with supersonic tip speed while the other is for subsonic tip speed propellers. Comparisons of the calculated and measured acoustic data for a conventional and an advanced propeller show good agreement in general. R.E.S.

**N79-32211\*** Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.  
**LEAN, PREMIXED, PREVAPORIZED FUEL COMBUSTOR CONCEPTUAL DESIGN STUDY Final Report**  
 A. J. Fiorentino, W. Greene, and J. Kim Washington NASA Aug. 1979 63 p refs  
 (Contract NAS3-21256)  
 (NASA-CR-159647; PWA-5626-12) Avail: NTIS HC A04/MF A01 CSCL 21E

Four combustor concepts, designed for the energy efficient engine, utilize variable geometry or other flow modulation techniques to control the equivalence ratio of the initial burning zone. Lean conditions are maintained at high power to control oxides of nitrogen while near stoichiometric conditions are maintained at low power for low CO and THC emissions. Each concept was analyzed and ranked for its potential in meeting the goals of the program. Although the primary goal of the program is a low level of nitric oxide emissions at stratospheric cruise conditions, both the ground level EPA emission standards and combustor performance and operational requirements typical of advanced subsonic aircraft engines are retained as goals as well. Based on the analytical projections made, two of the concepts offer the potential of achieving the emission goals; however, the projected operational characteristics and reliability of any concept to perform satisfactorily over an entire aircraft flight envelope would require extensive experimental substantiation before engine adaptation can be considered. A.R.H.

**N79-32214\*** National Aerospace Lab., Amsterdam (Netherlands). Flight Div.  
**HANDLING PROBLEMS RESULTING FROM COMPRESSOR DETERIORATION**  
 J. P. K. Vleghert 6 Jun. 1978 11 p Presented at AGARD Propulsion and Energetics Panel Symp. on Stresses, Vibration Structural Integration and Engine Integrity, Cleveland, 23-27 Oct. 1978  
 (NLR-MP-78019-U) Avail: NTIS HC A02/MF A01

The Royal Netherlands Air Force has experienced performance loss and increased rate of inflight compressor stalls due to compressor deterioration on some of their 15 year old engines. Investigations on the Maintenance Depot test bed showed that significant loss of air mass flow occurred near the surge line under conditions which were not covered by the normal post-overhaul acceptance tests. It was also found that impending stall was always produced by increasing pressure fluctuations, although the level of these pressure fluctuations varied with different engines. A method was developed to routine check for this phenomenon. The surge margin of the affected engines was recovered by replacing the rear compressor casing. Further investigation, conducted by the engine manufacturer to narrow down the reason for the engine's behavior, is discussed. Author (ESA)

**N79-32216\*** National Aerospace Lab., Amsterdam (Netherlands). Div. of Structures and Materials.  
**AIRCRAFT DESIGN LOADS DUE TO NON-STATIONARY ATMOSPHERIC TURBULENCE PATCHES**  
 R. Noback 27 Jun. 1978 90 p refs  
 (Contract NIVR-1775)  
 (NLR-TR-78073-U) Avail: NTIS HC A05/MF A01

It is assumed that atmospheric turbulence appears in patches and that within the patches the turbulence can be described as a modulated Gaussian process. The patch lengths are shown to have a certain probability density function. Load exceedance curves and design loads for various aircraft models using this turbulence model are compared with those obtained with the power spectral density (PSD) turbulence model. Results show that the PSD model is more powerful than the underlying assumptions suggest and that it should continue to be used for the establishment of design loads, as its application is less complicated, even though the modulated Gaussian turbulence patch model gives a better description of atmospheric turbulence. Author (ESA)

**N79-32218\*** Naval Civil Engineering Lab., Port Hueneme, Calif.  
**RECYCLING OF ASPHALT CONCRETE AIRFIELD PAVEMENT: A LABORATORY STUDY Final Report, Jan. 1977**  
**Dec. 1978**  
 R. B. Brownie and M. C. Hironaka May 1979 135 p refs  
 (Contract DOT-FA77WAI-704)  
 (AD-A072117; FAA-RD-78-58) Avail: NTIS HC A07/MF A01 CSCL 13/2

Aged asphalt concrete (AC) pavement samples, obtained from three Naval airfields and two civil airports, were used in laboratory experiments to develop and establish criteria and design guidelines for recycling such pavements. Tests were conducted on nine agents for softening residual asphalt cements and designed hot- and cold-mix samples. It was found that aged AC pavement materials can be recycled to meet FAA and Navy specifications for new pavement surfaces and base courses by hot-mix recycling procedures and new base courses by cold-mix recycling procedures. Based on the results of this investigation, criteria and design guidelines for recycling aged AC pavements by hot-mix and cold-mix procedures were established. A.R.H.

**N79-32219\*** Lockheed-Georgia Co., Marietta.  
**ESTIMATION OF TUNNEL BLOCKAGE FROM WALL PRESSURE SIGNATURES: A REVIEW AND DATA CORRELATION**  
 J. E. Hackett, D. J. Wilsden, and D. E. Lilley Mar. 1979 170 p refs  
 (Contract NAS2-9883)  
 (NASA-CR-152241) Avail: NTIS HC A08/MF A01 CSCL 14B

A method is described for estimating low speed wind tunnel blockage, including model volume, bubble separation and viscous wake effects. A tunnel-centerline, source/sink distribution is derived from measured wall pressure signatures using fast algorithms to solve the inverse problem in three dimensions. Blockage may then be computed throughout the test volume. Correlations using scaled models or tests in two tunnels were made in all cases. In many cases model reference area exceeded 10% of the tunnel cross-sectional area. Good correlations were obtained regarding model surface pressures, lift drag and pitching moment. It is shown that blockage-induced velocity variations across the test section are relatively unimportant but axial gradients should be considered when model size is determined. M.M.M.

**N79-32220\*** ARO, Inc., Arnold Air Force Station, Tenn.  
**A VORTEX LATTICE TECHNIQUE FOR COMPUTING VENTILATED WIND TUNNEL WALL INTERFERENCE Final Report, Jan. 1978 - Sep. 1977**  
 F. L. Heitsley and W. E. Dietz, Jr. AEDC Jun. 1979 30 p refs  
 (AD-A070445; AEDC-TR-79-21) Avail: NTIS HC A03/MF A01 CSCL 14/2

A vortex lattice method has been applied to the problem of predicting the interference induced by ventilated wind tunnel walls. The formulations of both perforated and slotted wall

boundaries using the vortex lattice method are presented. Wall interference effects on a single lifting line vortex for several basic wind tunnel test section configurations are compared with other theoretical results. Use of the vortex lattice method to calculate the aerodynamic characteristics of a lifting model too complex for exact analytical treatment is discussed. The surface pressure distribution on a combined wing and tail representation computed for a free stream is presented as well as those for both closed and slotted test sections to illustrate the capability of the technique. GRA

**N79-32221#** ARO, Inc., Arnold Air Force Station, Tenn.

**TUNNEL 16T PERFORMANCE: TWO-AND THREE-STAGE COMPRESSOR PERFORMANCE** Final Report

J. A. Reed AEDC 21 Feb. 1979 32 p  
(AD-A070191; AEDC-TSR-79-P10) Avail: NTIS  
HC A03/MF A01 CSCL 14/2

PWT Tunnel 16T compressor, C1, was operated in a two-stage configuration for the purpose of validating computer predicted results obtained with the COCODEC compressor code. The third rotor row of the three-stage machine was removed and an aluminum shroud was installed to provide a smooth flow passage over the voids created by the blade removal. The compressor was reconfigured to three stages and a verification run was made to ensure that no changes in the compressor performance had occurred during the two-stage modification and the reinstallation of the third rotor row. GRA

**N79-32222#** Calspan Corp., Buffalo, N. Y.

**SURVEY AND EVALUATION OF POTENTIAL REAL-TIME INTERACTIVE FLIGHT TEST FACILITIES FOR THE B-1**

W. Deazley and W. Shad 5 Jan. 1973 45 p  
(Contract F33657-71-C-1055)  
(AD-A070343; CALSPAN-BA-3103-N-101) Avail: NTIS  
HC A03/MF A01 CSCL 01/3

Real-time or real-time interactive flight testing (or displays) is the use of rapidly processed flight test data displayed in a form most effective for engineering evaluation or analysis at a rate permitting interaction between engineering personnel on the ground and the pilot in the test aircraft. The time delays involved in making the computations and absorbing the meaning of the displayed results of a particular test must be small enough to allow the engineer to communicate his satisfaction or concerns to the flight test controller and the pilot soon enough to permit re-testing, modifications, omission of the next step, or proceeding as planned. Typical delays of 1 or 2 minutes could probably be tolerated. GRA

**N79-32223#** ARO, Inc., Arnold Air Force Station, Tenn.

**AN EXPERIMENTAL INVESTIGATION OF THE ACOUSTIC CHARACTERISTICS OF A VARIETY OF SLOT BAFFLE CONFIGURATIONS FOR TRANSONIC WIND TUNNEL WALLS** Final Report, 1 Jul. 1976 - 30 Sep. 1977

N. S. Dougherty, Jr. AEDC Jun. 1979 73 p refs Sponsored by the Air Force  
(AD-A070261; AEDC-TR-79-16) Avail: NTIS  
HC A04/MF A01 CSCL 20/4

A parametric study of various slot baffle geometric configurations was performed in an effort to find an improvement to the acoustic characteristics of baffled slotted walls used in the NASA/Ames Research Center transonic wind tunnels. The desired improvement was to reduce the aerodynamic noise generated by these walls. Parameters studied were baffle inclination angle, shape, and depth. A modification to wall samples which effectively suppressed the noise generated by the baffled slots was a fine-mesh wire screen overlay in combination with baffle inclination angle. The degree of tunnel wall noise suppression achieved in the experiments was a factor of six less than the configuration now in use. Author (GRA)

**N79-32224#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

**CONSTRUCTION PROBLEMS FOR HIGH REYNOLDS NUMBER WIND TUNNEL MODELS**

Maurice Bazin 1978 36 p refs In FRENCH; ENGLISH summary Presented at 14th Colloq. d'Aerodyn. Appl. de l'Assoc. Aeron. et Astron. de France, Toulouse, 7-9 Nov. 1977 Report will also be announced as translation (ESA-77-564)  
(ONERA-NT-1978-6) Avail: NTIS HC A03/MF A01

The choice of materials, the structural design of the model and of removable or motorized elements as well as problems of definition are presented. Models for weighings and determining pressure distribution along with models of air intakes, of jet simulation, and dynamic flutter models are considered. The model definition and machining, relative to time and cost constraints that entail new construction methods, are discussed. It is shown that deformations in operation, under the effect of aerodynamic and thermal loads, require the implementation of new measuring techniques. The capacity, thermal protection, and calibration methods of the balances also have to be adapted. The mechanical strength of the supports, in particular regarding the risk of divergence, and the dynamic behavior of the mountings are the most severe limitations in the use of pressurized wind tunnels. Thermal effects are added in a cryogenic environment. These effects concern instrumentation considered and the evolution of detectors as well as of pressure measurement methods and instruments is considered. Author (ESA)

**N79-32265#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**RELEASE-RATE CALORIMETRY OF MULTILAYERED MATERIALS FOR AIRCRAFT SEATS**

L. L. Fewell, Fred Duskin (McDonnell Douglas Aircraft Co., Long Beach, Calif.), Howard Spieth (McDonnell Douglas Aircraft Co., Long Beach, Calif.), Ed Trabold (McDonnell Douglas Aircraft Co., Long Beach, Calif.), and J. A. Parker Aug. 1979 26 p refs (NASA-TM-78594; A-7856) Avail: NTIS HC A03/MF A01 CSCL 11G

Multilayered samples of contemporary and improved fire resistant aircraft seat materials (foam cushion, decorative fabric, slip sheet, fire blocking layer, and cushion reinforcement layer) were evaluated for their rates of heat release and smoke generation. Top layers (decorative fabric, slip sheet, fire blocking, and cushion reinforcement) with glass fiber block cushion were evaluated to determine which materials based on their minimum contributions to the total heat release of the multilayered assembly may be added or deleted. Top layers exhibiting desirable burning profiles were combined with foam cushion materials. The smoke and heat release rates of multilayered seat materials were then measured at heat fluxes of 1.5 and 3.5 W/sq cm. Choices of contact and silicone adhesives for bonding multilayered assemblies were based on flammability, burn and smoke generation, animal toxicity tests, and thermal gravimetric analysis. Abrasion tests were conducted on the decorative fabric covering and slip sheet to ascertain service life and compatibility of layers. Author

**N79-32276#** Lehigh Univ., Bethlehem, Pa.

**THREE-DIMENSIONAL LAMINATE PLATES WITH THROUGH AND PART-THROUGH CRACKS**

G. C. Sih In Duke Univ. Res. Workshop on Mech. of Composite Mater. 1978 p 201-208 refs (For primary document see N79-32267 23-24)  
Avail: NTIS HC A10/MF A01

The stress intensity factors for three dimensional composites are determined for a variety of material and geometrical parameters such as the stiffness ratio, the thickness ratio and the Poisson ratio, that control the nature of the three dimensional stress distribution. Assuming that the fracture toughness is known for the layer within which the crack propagation takes place, a desired combination of the desired parameters can be determined to maximize the load carrying capacity of the laminate. M.M.M.

**N79-32281#** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

**RESIDUAL STRENGTH PROPERTIES OF CARBON/EPOXY COMPOSITE MATERIALS**

W. G. J. Hart Jan. 1979 42 p refs  
(Contract NIVR-1744)  
(NLR-TR-77039-U) Avail: NTIS HC A03/MF A01

Fatigue tests on unidirectional carbon/epoxy composite materials were performed to investigate whether previous fatigue loading influences the residual static strength. Residual strength tests were carried out on (0, + or - 45) sub 2s and (+ or - 45) sub 2s laminates, while for the (0, + or - 45) sub 2s laminate, the influence of previous tensile fatigue loading on the residual strength was investigated. Results show that the fatigue properties under tensile fatigue loading of unidirectional carbon/epoxy composite materials are excellent provided that the load introduction does not result in shear stresses.

Author (ESA)

**N79-32283#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Structures and Materials.

**ENVIRONMENTAL FATIGUE CRACK PROPAGATION IN METAL/COMPOSITE LAMINATES**

R. J. H. Wanhill Jun. 1978 24 p refs Submitted for publication

(NLR-MP-78027-U) Avail: NTIS HC A02/MF A01

Flight simulation fatigue crack propagation tests with gust spectrum loading were carried out on 2024-T3/carbon-epoxy, 7475-T761/carbon-epoxy, and Ti-6Al-4V/carbon-epoxy laminates with nominal weight savings of 30% as compared to equivalent 2024-T3 panels. The performance of the 2024-T3/carbon-epoxy laminates was much superior to those of the other material combinations. Overall, there was a fairly strong effect caused by changing from an environment of normal air to an air plus water spray environment. Probable reasons for this strong effect are discussed.

Author (ESA)

**N79-32287#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Structures and Materials.

**RESIDUAL STRENGTH OF (0, + OR - 45) SUB s AND (+ OR - 45, 0) SUB s CARBON/EPOXY LAMINATES**

W. G. J. Hart 15 Jan. 1979 32 p refs

(Contract NIVR-1744)

(NLR-TR-77115-U) Avail: NTIS HC A03/MF A01

Residual strength tests were carried out on (0, + or - 45) sub s and (+ or - 45, 0) sub s carbon/epoxy laminates containing holes or cracks. The influence of specimen width on the residual strength was investigated for (0, + or - 45) sub s carbon/epoxy specimens. Results show that the residual strength is independent of the laminate stacking sequence for simulated cracks. The residual strength of (+ or - 45, 0) sub s and (0, + or - 45) sub s carbon/epoxy laminates containing holes is highest for the latter laminate configuration. Residual strength tests on (0, + or - 45) sub s carbon/epoxy specimens of different widths indicate that the residual strength behavior (corrected for finite width) is independent of the specimen width. Author (ESA)

**N79-32288#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Structures and Materials.

**ENVIRONMENTAL FATIGUE CRACK PROPAGATION IN METAL/COMPOSITE LAMINATES** Interim Report

R. J. H. Wanhill 15 Jan. 1979 26 p refs

(Contract NIVR-1806)

(NLR-TR-77122-U; IR-1) Avail: NTIS HC A03/MF A01

Flight simulation fatigue crack propagation tests with gust spectrum loading were carried out on 2024-T3/carbon-epoxy, 7475-T761/carbon-epoxy, and Ti-6Al-4V/carbon-epoxy laminates with nominal weight savings of 30 percent as compared to equivalent 2024-T3 panels. The performance of the 2024-T3/carbon-epoxy laminates was much superior to those of the other material combinations. Overall, there was a fairly strong effect noted when changing from an environment of normal air to an air plus water spray environment. Probable reasons for the strong effect are discussed.

Author (ESA)

**N79-32344#** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

**ALUMINUM ALLOYS FOR ADVANCED STRUCTURAL APPLICATIONS IN TRANSPORT AIRCRAFT**

R. J. H. Wanhill Feb. 1979 33 p refs Submitted for publication

(NLR-MP-77023-U) Avail: NTIS HC A03/MF A01

Three topics of interest for aluminum alloy aircraft structural materials are discussed. These are the advent of metallurgically cleaner alloys like 2124, 2048 and 7475, possessing higher fracture toughness than older materials, e.g. 2024 and 7075, the potential application of 7000 series alloys (notably 7475) in tension panels, rather than the customary 2000 series alloys, and the development of alloys like 7049, 7050 and 7010, combining high strength through thick sections with high fracture toughness and good resistance to stress corrosion and exfoliation. Two developments which may reach commercial production status in the future are also considered. These are powder metallurgy alloys for extrusions and forgings with improved stress corrosion resistance, fracture toughness, and fatigue strengths as compared to conventional materials, and thermomechanical treatment to achieve combinations of properties unobtainable from conventional processing.

Author (ESA)

**N79-32350#** National Aerospace Lab., Amsterdam (Netherlands). Div. of Structures and Materials.

**EFFECT OF AN ANTI-CORROSION PENETRANT ON THE FATIGUE LIFE OF VARIOUS RIVETED JOINTS DURING FLIGHT SIMULATION TESTS**

J. Schijve, F. A. Jacobs, and P. J. Tromp 15 Jan. 1979 33 p refs

(Contract NIVR-1725)

(NLR-TR-77103-U) Avail: NTIS HC A03/MF A01

Comparative flight simulation tests on four types of joints of 2024-T3 sheet material were carried out with and without application of the penetrant LPS-3. Types of joints tested were double strap joints with hi-lok bolts, asymmetric strap joints, lap joints with countersunk rivets, and lap joints with dimpled holes. Observations on slip during the fatigue tests as well as during static tests to failure were made. A reduction in fatigue life was observed in asymmetric strap joints and simple lap joints, but no reduction was found for the other types of joints tested. The effect depends on the design of the joint, while the maximum load during the test may also be significant in view of the occurrence of slip.

Author (ESA)

**N79-32381#** Department of Energy, Washington, D. C. Energy Research Center.

**AVIATION TURBINE FUELS, 1978**

E. M. Shelton May 1979 15 p refs

(BETC/PPS-79/2) Avail: NTIS HC A02/MF A01

Properties of some aviation turbine fuels marketed in the United States during 1978 are presented. The samples represented are typical 1978 production and were analyzed in the laboratories of 15 manufacturers of aviation turbine (jet) fuels. Results for the properties of 90 samples of aviation turbine fuels are included in the report for military grades JP-4 and JP-5, and commercial type Jet A.

DOE

**N79-32415#** Federal Aviation Agency, Atlantic City, N.J.

**NUMERICAL STUDIES OF CONVERSION AND TRANSFORMATION IN A SURVEILLANCE SYSTEM EMPLOYING A MULTITUDE OF RADARS, PART 2**

R. G. Mulholland and D. W. Stout Apr. 1979 58 p refs 2 Vol. (AD-A072086; FAA-NA-79-18-Pr-2) Avail: NTIS HC A04/MF A01 CSCL 17/9

Scale magnification and transformation errors are considered in the application of stereographic projection to the planar representation of target latitude and longitude relative to the reference ellipsoid in a multiple radar surveillance system. The representation is accomplished by conversion of target altitude together with target azimuth and slant range relative to a radar into a point on a plane unique to the radar. This is followed by a transformation that carries points on the local radar plane into points on a single master plane. Transformation error is viewed as the separation of images on the master plane of the same point in the local radar plane under an ideal mapping formula and polynomial approximations. Tight upper and lower bounds are derived for the error generated by these approximations under parameter constraints consistent with the structure of practical coverage regions.

J.M.S.

**N79-32416#** Federal Aviation Agency, Atlantic City, N.J.  
**NUMERICAL STUDIES OF CONVERSION AND TRANSFORMATION IN A SURVEILLANCE SYSTEM EMPLOYING A MULTITUDE OF RADARS, PART 1**  
R. G. Mulholland and D. W. Stout May 1979 43 p refs 2 Vol.  
(AD-A072085: FAA-NA-79-17-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 17/9

Conversion error is considered in the application of stereographic projection to the planar representation of targets in multiple radar surveillance systems. The error is treated as the separation of images in a local radar plane of target positions (in terms of altitude, azimuth, and slant range) under ideal mapping formulas and system implementations. These images are viewed as elements of a complex plane in which the center of coordinates represents the radar site. Thus, conversion error can be expressed in terms of a range error equal to the difference in moduli of two complex numbers and an angle error equivalent to the difference between the arguments of the same numbers. As the image of target position under ideal conversion traverses a circle centered on the origin of coordinates, both the angle error and the range error oscillate about median values. The amplitude of each oscillation increases with the radius of the circle. In addition, the median range error is strongly dependent upon the radius of the circle. An error correction method and a commonly used minimax technique are considered as alternative means for controlling conversion error. J.M.S.

**N79-32417#** Atlantic Scientific Corp., Indian Harbour Beach, Fla. Office of Naval Research.  
**AN INVESTIGATION INTO THE NOISE INTERFERENCE PROBLEMS AT LOGAN AIRPORT, BOSTON** Final Report, Aug. 1977 - Apr. 1979

Barton J. Lipofsky, Rodney B. Bent, Sigred K. Llewellyn, and Jack Leahy (FAA, Burlington, Mass.) Apr. 1979 106 p refs (Contract DOT-FA77WAI-774)  
(AD-A072057: FAA-RD-79-58) Avail: NTIS HC A06/MF A01 CSCL 17/2

A severe noise problem exists at many air traffic control tower locations in the VHF receivers during certain severe weather conditions. The problem was theoretically investigated for Boston Logan Airport and was found to be most likely related to corona discharge from air terminals close to the receiving antennas. Elimination techniques using static dischargers at some ATCT locations were analyzed and are criticized. A detailed experimental study of the effect of corona noise on voice communications was carried out using receivers and antennas which are representative of equipment in current use at air traffic control centers. G.Y.

**N79-32418#** National Aviation Facilities Experimental Center, Atlantic City, N.J.  
**INTERIM RESULTS OF DABS/ATCRBS ELECTROMAGNETIC COMPATIBILITY TESTING** Interim Report, Mar. - Jun. 1979

George Mahnken and Leo Wapelhorst Jun. 1979 101 p  
(AD-A072087: FAA-RD-79-11; FAA-NA-79-180) Avail: NTIS HC A06/MF A01 CSCL 20/14

Tests were conducted and results were presented at the National Aviation Facilities Experimental Center (NAFEC) to determine what effect the implementation of the Discrete Address Beacon System (DABS) has on the performance of the Air Traffic Control Radar Beacon System (ATCRBS). Uplink tests were conducted to measure transponder suppression rates in the ATCRBS airborne environment under various DABS and ATCRBS ground interrogator site configurations. Analysis of the data collected to date indicates that suppression levels generally become lower when DABS sensors replace ATCRBS sites, thus, resulting in an improvement in the ATCRBS airborne environment. Tests were also conducted on three reply processors being used by the Federal Aviation Administration in operational facilities to process ATCRBS targets to determine processor susceptibility to DABS fruit interference. There was no indication from the resultant data of any significant degradation in performance in the presence of varying amounts of DABS fruit. M.M.M.

**N79-32420#** Mississippi State Univ., Mississippi State, Dept. of Electrical Engineering.  
**A STUDY OF THE EMP INTERACTION WITH AIRCRAFT OVER AN IMPERFECT GROUND PLANE** Final Report  
C. Taylor, V. Naik, and T. Crow May 1979 53 p refs (Grant AF-AFOSR-3342-77; AF Proj. 3763)  
(AD-A070388: AFWL-TR-78-163) Avail: NTIS HC A04/MF A01 CSCL 18/3

The study of thin wire configurations, in particular the isolated single wire and crossed wires, above the ground plane has been conducted utilizing analytical techniques primarily. The formulation is based on transmission line theory and the singularity expansion method (SEM). Natural frequencies, natural current modes and coupling coefficients are determined. These results are compared with the results obtained by earlier investigators using conventional numerical techniques. GRA

**N79-32422#** Rome Air Development Center, Griffiss AFB, N.Y.  
**RADIATION PATTERN SIDEBLOBES AND NULL FILLING PRODUCED BY AIRCRAFT VIBRATION**  
Ronald L. Fante Jan. 1979 21 p ref (AF Proj. 2305)  
(AD-A070472: RADC-TR-79-6) Avail: NTIS HC A02/MF A01 CSCL 20/14

We have studied the effect of the temporal vibrations of an array of radiators on their radiation pattern. Results are obtained for both large and small vibration amplitudes in the limit when the vibrations are periodic. In general the vibration-induced sidelobe levels are found to depend on the size of the vibration in wavelengths, the spatial distance over which the vibrations are correlated, and the number of elements in the array. GRA

**N79-32441#** Boeing Co., Seattle, Wash.  
**INVESTIGATION OF PENETRATION OF ELECTROMAGNETIC ENERGY THROUGH JOINTS IN ADVANCED COMPOSITE STRUCTURES** Interim Report  
D. F. Straw and L. D. Piszke Apr. 1979 90 p refs (Contract N00019-79-C-0058)  
(AD-A069589: D180-25240-1) Avail: NTIS HC A05/MF A01 CSCL 13/5

The objectives of this effort are to conduct an investigation of the effects of electromagnetic energy on advanced composite aircraft structures and their associated avionic/electrical equipment. The primary objective of this investigation is to develop test techniques to evaluate the coupling of electromagnetic energy through joints in the composite materials within the frequency range 10 kHz to GHz. A test setup will be designed, fabricated, and checked out to perform measurements over a portion of this frequency range and joint admittance data will be obtained on a variety of structural joint samples. At the conclusion of this investigation, the test fixture will be delivered to NASC. GRA

**N79-32468#** General Electric Co., Binghamton, N.Y. Aerospace Controls and Electrical Systems Dept.  
**THE 150 KVA SAMARIUM COBALT USCF STARTER GENERATOR ELECTRICAL SYSTEM** Final Technical Report, 1 Jun. 1974 - 31 May 1978  
David L. Lafuze, Robert C. Webb, Charles F. Triebel, George E. Brissey, and Albert C. Foss Dec. 1978 204 p refs (Contract F33615-74-C-2037; AF Proj. 3145)  
(AD-A070078: AES-11730; AFAPL-TR-78-104) Avail: NTIS HC A10/MF A01 CSCL 10/2

This report documents the development, construction and test of a 150 KVA Starter/Generator Variable Speed Constant Frequency (VSCF) electrical system which includes a solid rotor machine using rare earth samarium cobalt magnets. The system consists of the solid rotor 14-pole starter/generator which in the generate mode, is driven at 12,000 to 21,000 RPM and a cycloconverter which, converts the 9-phase variable frequency power from the generator to a high quality 3-phase, 400 Hz, 150 KVA power source. In the start mode, the cycloconverter converts 3-phase, 400 Hz power to a 9-phase variable frequency, variable voltage which is used to power the starter/generator as the equivalent of a brushless DC motor. The rotor was developed

during the first phase of the program which is reported on in detail in AFAPL-TR-76-8. The generator is oil cooled and uses a self-contained oil pump. It also includes a high speed mechanical disconnect which is solenoid operated to remove drive power and is mechanically reset at zero speed. The stator core uses 0.006 inch permendur laminations to handle high flux densities with a minimum of eddy current losses. The cycloconverter uses a dip brazed chassis, with liquid (oil) cooled cold plates for heat extraction. The major volume in the converter houses the power handling components which include 54 SCRs, 18 interphase transformers, 15 output filter capacitors and input despiker components. GRA

**N79-32551\*** Avco Lycoming Div., Stratford, Conn.

**DEVELOPMENT OF SPIRAL-GROOVE SELF-ACTING SEALS FOR HELICOPTER ENGINES** Final Report, 10 Jun. 1977 - 31 Dec. 1978

Michael OBrien Jun. 1979 62 p Sponsored in part by Army Res. and Technol. Labs.

(Contract NAS3-20795)

(NASA-CR-159622: LYC-79-25) Avail: NTIS HC A04/MF A01 CSCL 11A

A spiral-groove, self-acting face seal was rig tested at advanced gas turbine operating conditions to determine wear and leakage rates. The spiral-groove, self-acting geometry was located in the rotating seal seat. Seal component wear induced by start-stop operation was measured after subjecting the test seal to 176 start-stop cycles. Wear occurring during normal operation was documented throughout a 75-hour endurance test. Seal air leakage was also measured. During endurance operation, the seal was subjected to operating conditions bounded by the values surface speed - 244 m/s (800 ft/sec), air pressure - 148 N/sq cm abs (215 psia), and air temperature - 622 K (660 F). The post-test condition of the seal components was documented. Wear data is presented in tabular form, while seal air leakage is presented graphically, as a function of pressure and speed. F.O.S.

**N79-32560\*** Battelle Columbus Labs., Ohio.

**MULTIFREQUENCY EDDY CURRENT INSPECTION FOR CRACKS UNDER FASTENERS, PHASE 2** Final Technical Report, Apr. 1977 - Nov. 1978

G. H. Wilson, D. T. Hayford, and R. P. Meister Mar. 1979 72 p

(Contract F33615-76-C-5062: AF Proj. 7351) (AD-A071102: AFML-TR-79-4023) Avail: NTIS HC A04/MF A01 CSCL 14/2

This report describes the second phase of a two-phase program. Phase I, reported in TR-76-209, was directed toward the evaluation and demonstration of multiple frequency eddy-current (MFEC) using wing-splice samples and laboratory instrumentation to detect cracks under titanium and steel fasteners. This Phase II report covers the development evaluation of a prototype MFEC system for field use. The system was built around commercially available micro-computer modules coupled with in-house designed eddy current electronics, an eddy current probe, and a multifunction operator control panel. The system was 'trained' using two C-5A wing panel sections having sawcuts to simulate cracks. Tenth-inch sawcuts at the top of the second layer could be repeatedly detected using a decision algorithm based on a combination of four frequencies. The prototype system was evaluated during July, 1978, as part of the C-5A Structural Evaluation and Inspection Program (SEIP). Of approximately 400 fasteners inspected with the system, one suspect was found and later confirmed with another NDE method. In continued development of the MFEC technique, methods must be investigated which will be tolerant of variations in geometry found around rib stiffeners and single fastener rows. GRA

**N79-32594\*** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Dept.

**A FINITE ELEMENT MODEL TO STUDY THE BUCKLING BEHAVIOR OF GENERAL ORTHOTROPIC, MIDPLANE SYMMETRIC, ELASTIC PLATES**

J. F. M. Wiggenraad Jan. 1979 28 p ,refs

(Contract NIVR-1808)

(NLR-TR-77062-U) Avail: NTIS HC A03/MF A01

A finite element model was developed which incorporates the bending-torsional coupling effect as it occurs in general orthotropic, midplane symmetric, elastic plates in order to analyze its influence on the buckling behavior of such plates. Some of the results were compared with known exact and approximate solutions. Indications are that values for the case of pure compression are more accurate than for the case of pure shear. Values derived for simply supported plates are also more accurate than those for clamped plates. It is concluded that a 4 x 4 grid size gives good results for the analysis of the stability of isotropic and special orthotropic plates. However, for general orthotropic plates an increase in grid size is necessary. Author (ESA)

**N79-32596\*** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

**ENGINEERING APPLICATION OF FRACTURE MECHANICS TO FLIGHT SIMULATION**

R. J. H. Wanhill May 1978 12 p refs Presented at Intern. Conf. on Fracture Mech. in Eng. Appl., Bangalore, India, Mar. 1979

(NLR-MP-78015-U) Avail: NTIS HC A02/MF A01

Experimental data on the fracture mechanics of flight simulation crack propagation were studied and a characteristic, K, was derived. The phenomena considered were design stress level, gust severity, spectrum truncation, and crack growth from one of both sides of a hole. Results show that for a change in design stress level up to 25% the data is correlated fairly well by K, except when crack growth rate correlations due to severe flights were not transient with respect to the overall trend of growth rates. Gust severity effects are correlated by  $K_a$  sub rms, the stress intensity pertaining to the root mean square of the gust amplitudes. However, gust alleviation and spectrum truncation effects are not correlatable by a K value descriptive of changes in the load excursion magnitudes. Crack growth rates at each tip of a crack at one or both sides of a circular hole are correlated by a characteristic K. Author (ESA)

**N79-32597\*** National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

**GUST SPECTRUM FATIGUE CRACK PROPAGATION IN CANDIDATE SKIN MATERIALS**

R. J. H. Wanhill May 1978 32 p refs Submitted for publication

(NLR-MP-78022-U) Avail: NTIS HC A03/MF A01

Flight simulation fatigue crack propagation tests were carried out on 2024-T3, 7475-T761, and mill annealed Ti-6Al-4V sheet in thicknesses up to 3 mm. These materials are representative of those used in transport aircraft lower wing skin stiffened panels with end load capacities of 1.5 and 3 MN/m. The performance of 2024-T3 was much superior to the others, owing mainly to greater retardation of crack growth after severe flights. The effect of load truncation was also greater for 2024-T3. The significance of the results of the choice of advanced structural concepts and materials, and the choice of truncation level is discussed. A recommendation for further investigation is given.

Author (ESA)

**N79-32637\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**COMPARISON OF ALTERNATE FUELS FOR AIRCRAFT**

Robert D. Witcofski Sep. 1979 38 p refs Presented at the International DGLR/DFLR Symp. on Hydrogen in Air Transportation, Stuttgart, Germany, 11-14 Sep. 1979

(NASA-TM-80155) Avail: NTIS HC A03/MF A01 CSCL 21D

Liquid hydrogen, liquid methane, and synthetic aviation kerosene were assessed as alternate fuels for aircraft in terms of cost, capital requirements, and energy resource utilization. Fuel transmission and airport storage and distribution facilities are considered. Environmental emissions and safety aspects of fuel selection are discussed and detailed descriptions of various fuel production and liquefaction processes are given. Technological deficiencies are identified. K.L.

**N79-32969# Man-Acoustics and Noise, Inc., Seattle, Wash.  
COMMERCIAL AIRCRAFT FLIGHT DECK NOISE CRITERIA  
Final Report**

J. E. Mabry, B. M. Sullivan, and R. A. Shields Jan. 1979  
71 p refs

(Contract DOT-FA77WAI-723)  
(AD-A072029; FAA-RD-79-66; MAN-1037) Avail: NTIS  
HC A04/MF A01 CSCL 20/1

As a method for obtaining results that could contribute to the establishment of commercial jet aircraft flight deck noise criteria, fifty persons were exposed to simulations of various flight deck noise exposure conditions. Exposure levels investigated were 75, 80 and 85 dBA for periods of 1, 2, and 4 hours. Noise spectra representing both older narrow-body and newer technology wide-body jet aircraft were utilized. Response measures emphasized were temporary threshold shift (TTS) and speech intelligibility, but annoyance ratings to the exposure conditions were also obtained. Author

**N79-32974# Polytechnic Inst. of New York, Brooklyn. Dept.  
of Mechanical and Aerospace Engineering.**

**SOME NONLINEAR PROBLEMS IN TRANSONIC HELICOPTER ACOUSTICS Final Report**

Morris P. Isom May 1979 64 p refs  
(Grant DAAG29-76-G-0035)

(AD-A069564; POLY-M/AE-79-19; ARO-12937.1-E) Avail:  
NTIS HC A04/MF A01 CSCL 20/1

The nonlinear potential equation that determines the near aerodynamic and far acoustic fields of a hovering transonic helicopter blade is derived. Properties of this equation provide a qualitative description of characteristic surfaces associated with the nonlinear flow field. A simple linearized acoustic formula is developed; a nonlinearization scheme is then applied to this formula, and the linear and nonlinear acoustic pressure profiles, including propagating acoustic shock waves, are numerically determined and compared with experimental data. A tentative conclusion is that the radiated sound field should become measurably different when the blade tip first punctures the sonic surface associated with the rotor differential equation. This conjecture is suggested by the mathematical properties of the rotor equation and recent experimental work. GRA

**N79-33150# Deutsche Forschungs- und Versuchsanstalt fuer  
Luft- und Raumfahrt, Cologne (West Germany).**

**SCIENTIFIC RESEARCH, 1977 Annual Report [JAHRES-  
BERICHT 1977]**

1978 149 p In GERMAN Original contains color illustrations  
Avail: NTIS HC A07/MF A01

A general overview of technology developments in air transportation, aircraft design, space flight technology, reconnaissance, and energy and propulsion systems is given. Specific topics covered include: (1) future systems, safety, and guided flights; (2) models of pilot-cabin interfaces, aerodynamics, aeronautics, control systems including automatic control, missiles, rotary wings, and weight reduction; (3) intelligence, target recognition, and underwater techniques; (4) probes and space laboratories; and (5) turbogenerators, noise reduction, reduction of emissions, and high energy lasers. J.M.S.

**N79-33155# General Accounting Office, Washington, D. C.  
Logistics and Communications Div.**

**IF ARMY HELICOPTER MAINTENANCE IS TO BE READY  
FOR WARTIME, IT MUST BE MADE EFFICIENT AND  
EFFECTIVE IN PEACETIME**

10 May 1979 54 p  
(PB-295300/8; LCD-79-407) Avail: NTIS HC A04/MF A01  
CSCL 01C

The improvement of the Army's 8,000 helicopters depot maintenance was considered. The realistic requirements were discussed along with the appropriate resources needed to meet them. It was concluded that the Army should apply the reliability centered maintenance-concept forming as long as it is economic, safe, and reliable for engine components. Depot effectiveness

could be further improved if the Army reduced concurrent rework of aircraft components and made greater use of batch processing. GRA

**N79-33159# National Aeronautics and Space Administration.  
Hugh L. Dryden Flight Research Center, Edwards, Calif.**

**FLIGHT DETERMINED LIFT AND DRAG CHARACTERISTICS OF AN F-8 AIRPLANE MODIFIED WITH A SUPER-CRITICAL WING WITH COMPARISON TO WIND-TUNNEL RESULTS**

Jon S. Pyle and Louis L. Steers Jun. 1975 87 p  
(NASA-TM-X-3250; H-843) Avail: NTIS HC A05/MF A01  
CSCL 01A

Flight measurements obtained with a TF-8A airplane modified with a supercritical wing are presented for altitudes from 7.6 kilometers (25,000 feet) to 13.7 kilometers (45,000 feet). Mach numbers from 0.6 to 1.2, and Reynolds numbers from  $0.8 \times 10^6$  to the 7th power to  $2.3 \times 10^6$  to the 7th power. Flight results for the airplane with and without area-rule fuselage fairings are compared. The techniques used to determine the lift and drag characteristics of the airplane are discussed. Flight data are compared with wind-tunnel model results, where applicable. Author

**N79-33162# Scientific Research Associates, Inc., Glastonbury,  
Conn.**

**A VISCOUS FLOW ANALYSIS FOR THE TIP VORTEX  
GENERATION PROCESS**

S. J. Shamroth and W. R. Briley Washington NASA Oct.  
1979 77 p refs  
(Contract NAS1-14904)

(NASA-CR-3184) Avail: NTIS HC A05/MF A01 CSCL 01A

A three dimensional, forward-marching, viscous flow analysis is applied to the tip vortex generation problem. The equations include a streamwise momentum equation, a streamwise vorticity equation, a continuity equation, and a secondary flow stream function equation. The numerical method used combines a consistently split linearized scheme for parabolic equations with a scalar iterative ADI scheme for elliptic equations. The analysis is used to identify the source of the tip vortex generation process, as well as to obtain detailed flow results for a rectangular planform wing immersed in a high Reynolds number free stream at 6° degree incidence. Author

**N79-33163# Bihrl Applied Research, Inc., Jericho, N. Y.  
ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE  
GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK  
RANGE OF 8 DEG TO 90 DEG. 2: LOW-WING  
MODEL B**

William Bihrl, Jr. and Randy S. Hultberg Washington NASA  
Sep. 1979 345 p refs  
(Contract NAS1-14849)

(NASA-CR-3098) Avail: NTIS HC A15/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in the spin tunnel are presented in plotted form for a 1/6.5 scale, single engine, low wing, general aviation airplane model. The configurations tested included the basic airplane, various wing leading-edge devices, tail designs, and rudder control settings as well as airplane components. Data are presented without analysis for an angle-of-attack range of 8 deg to 90 deg and clockwise and counter-clockwise rotations covering an  $(\omega/\omega_0)/2V$  range from 0 to 0.85. Author

**N79-33164# National Aeronautics and Space Administration.  
Langley Research Center, Hampton, Va.**

**LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A  
VECTORED-ENGINE-OVER-WING CONFIGURATION AT  
SUBSONIC SPEEDS**

Laurence D. Leavitt Oct. 1979 136 p refs  
(NASA-TP-1533; L-13108) Avail: NTIS HC A07/MF A01  
CSCL 01A

The Langley V/STOL tunnel was used to determine the effects of vectored exhaust flow on the longitudinal aerodynamic

characteristics of a vectored-engine-over-wing configuration. Vectoring was accomplished by blowing from over-wing-mounted engines over a variable trailing-edge flap. Effects of varying canard geometry and wing leading-edge geometry were investigated. Wind-tunnel data were obtained at a Mach number of 0.186 for an angle-of-attack range from -20 deg to 24 deg and engine nozzle pressure ratios from 1.0 (jet off) to approximately 3.75.

A.R.H.

**N79-33172\*** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**COMPARATIVE ANALYSIS OF PA-31-350 CHIEFTAIN (N44LV) ACCIDENT AND NASA CRASH TEST DATA**

Robert J. Hayduk Washington Oct. 1979 59 p refs (NASA-TM-80102; L-13064) Avail: NTIS HC A04/MF A01 CSCL 01C

A full scale, controlled crash test to simulate the crash of a Piper PA-31-350 Chieftain airplane is described. Comparisons were performed between the simulated crash and the actual crash in order to assess seat and floor behavior, and to estimate the acceleration levels experienced in the craft at the time of impact. Photographs, acceleration histories, and the tested airplane crash data is used to augment the accident information to better define the crash conditions. Measured impact parameters are presented along with flight path velocity and angle in relation to the impact surface.

A.W.H.

**N79-33173\*** Douglas Aircraft Co., Inc., Long Beach, Calif. **HIGH SPEED BIRD IMPACT TESTING OF AIRCRAFT TRANSPARENCIES** Final Report, Jul. 1975 - Jun. 1978

M. J. Coker and R. H. Magnusson Jun. 1978 254 p refs (Contract F33615-75-C-3105; AF Proj. 2202) (AD-A071814; MDC-J7184; AFFDL-TR-77-98) Avail: NTIS HC A12/MF A01 CSCL 01/3

This report documents the test plans, test results and analyses of a series of high speed bird impact tests conducted on the B-1 X-5 Module windshield and on 36 x 36 inch simulated windshield test specimens as a portion of the work accomplished for the 'Windshield Technology Demonstrator Pro'. The testing, analyses and development accomplished during this program involved a total system approach required for aircraft windshields in the context of the continuing Air Force generic windshield development programs. Tests were conducted to evaluate the bird impact resistance of glass and plastic windshield panels and associated supporting structure being considered for use in the B-1 aircraft. Strain and deflection measurements were made on the test panels and supporting structure on most of the tests. A description of the tests and results obtained are presented.

GRA

**N79-33174\*** National Technical Information Service, Springfield, Va.

**BIRD STRIKES AND AVIATION SAFETY. A BIBLIOGRAPHY WITH ABSTRACTS** Progress Report, 1964 - Jun. 1979 Guy E. Habercom, Jr. Jul. 1979 99 p Supersedes NTIS/PS-78/0694, NTIS/PS-77/0606, and NTIS/PS-76/0538 (NTIS/PS-79/0753/8; NTIS/PS-78/0694; NTIS/PS-77/0606; NTIS/PS-76/0538) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 01B

Hazards to aircraft created by engine ingestion or airplane interception of birds are investigated in these Government-sponsored research reports. Bird damage assessment, structural strengthening, windshield design, and bird tracking and dispersal methods are studied. Ninety abstracts are included.

GRA

**N79-33176\*** National Transportation Safety Board, Washington, D. C. Bureau of Technology.

**SINGLE ENGINE, FIXED WING GENERAL AVIATION ACCIDENTS** Special Study, 1972 - 1976

31 May 1979 82 p (PB-297216/4; NTSB-AA-79-1) Avail: NTIS HC A05/MF A01 CSCL 01B

The factors associated with 17,312 general aviation accidents which occurred from 1972 through 1976 involving 17,498 light, single-engine, fixed-wing aircraft were examined. These aircraft accounted for 81.0 percent of the accidents, 76.0 percent of

the fatal accidents and 69.2 percent of the fatalities involving general aviation aircraft during that period. The factors considered include aircraft make, model, configuration -- such as tail wheel or tricycle landing gear and high- or low-wing configuration -- the pilot, and the environment. Certain aircraft makes, models, and characteristics were shown to be associated with high accident rates.

GRA

**N79-33177\*** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**AUTONOMOUS NAVIGATION SYSTEM Patent Application** Shmuel J. Merhav, inventor (to NASA) (National Research Council, Haifa, Israel) Filed 24 Sep. 1979 19 p Sponsored by NASA (NASA-Case-ARC-11257-1; US-Patent-Appl-SN-078611) Avail: NTIS HC A02/MF A01 CSCL 17G

A low cost autonomous navigation system which dispenses with accelerometers used in the conventional gimballed and strapdown inertial systems is described. The navigation system provides longitudinal and lateral vehicular specific force measurements in the locally level plane irrespective of the vehicle pitch, roll, and yaw motions. The navigation system provides longitudinal and lateral velocities in locally level geography coordinates along with vehicle position, altitude and attitude information. The system minimizes the number of sensors and system complexity, thus reducing errors, while providing a rapid method of north calibration. The system is composed of an unbalanced, pendulous, two axis gimbal system with a two degree of freedom leveling gyroscope and a heading gyroscope.

A.W.H.

**N79-33178\*** National Aviation Facilities Experimental Center, Atlantic City, N. J.

**AIR TRAFFIC CONTROL/FULL BEACON COLLISION AVOIDANCE SYSTEM CHICAGO SIMULATION** Final Report, Mar. - Apr. 1978

B. Billmann, T. Morgan, and R. Strack Apr. 1979 100 p refs (FAA Proj. 052-241-310) (AD-A069524; FAA-RD-79-16) Avail: NTIS HC A05/MF A01 CSCL 17/7

Air Traffic Control/Full Beacon Collision Avoidance System (ATC/BCAS) interaction in a high-density terminal area (featuring parallel instrument landing system (ILS) approaches) was investigated. Data are provided for a comparative study between BCAS and other aircraft collision avoidance systems. The tests were conducted using the Air Traffic Control Simulation Facility (ATCSF) at NAFEC during March and April 1978. Analysis of the results indicated that the presence of BCAS had no adverse impact on the controllers or control procedures because of a very low interaction rate. Controllers were generally indifferent to the use of the BCAS during the simulation. A significant number of controllers desired the displaying of negative commands. Certain changes in the BCAS logic are identified. Recommendations are made to investigate further desensitization techniques and further development of a multi-aircraft resolution logic, and to perform additional real-time simulation to assess the effect of profile descent procedures on BCAS alert rates.

G.Y.

**N79-33179\*** Lincoln Lab., Mass. Inst. of Tech., Lexington. **NEXT GENERATION AIRPORT SURVEILLANCE RADAR (ASR-1) DEFINITION STUDY** Final Report, Oct. 1974 - Oct. 1975

Jun. 1979 121 p refs Prepared in cooperation with APL and MITRE Corp. Sponsored by FAA (AD-A072691; FAA-RD-78-65) Avail: NTIS HC A06/MF A01 CSCL 17/7

The characteristics of the next generation airport surveillance radar (ASR) are investigated along with developed technology in airport radar utilization. The operational requirements of the ASR are defined including the coverage of small aircraft. The operating frequency, the antenna design, digital processing techniques, and a beacon system augmentation are examined.

A.W.H.

**N79-33180\*** Federal Aviation Administration, Washington, D. C. Systems Research and Development Service.

**HELICOPTER AIR TRAFFIC CONTROL OPERATIONS** Final Report

May 1979 113 p refs  
(Contract DOT-FA78WAI-936)  
(AD-A072793; FAA-RD-78-150; T-79-ES-06-U) Avail: NTIS  
HC A06/MF A01 CSCL 17/7

The problems which inhibit the integration of IFR operations in the ATC system were examined, and recommendations were made to resolve these problems. Revisions in TERPS criteria and in the ATC Handbook are necessary to minimize interference between fixed-wing and rotary-wing aircraft. The use of 2 nm radar separation between IFR helicopters in terminal areas is recommended to increase capacity by reducing the time interval between helicopter approaches to a value consistent with the time interval between fixed-wing approaches. Helicopters have a special need for low altitude RNAV capability and the ATC system needs to be better adapted to handle the random route traffic that helicopters will generate in exploiting their special capabilities. To this end, it is recommended that the FAA develop software to call up and display, on the ATC PPI, random waypoints and connecting routes, on an as-needed basis. Helicopters operating offshore and in remote areas are often beyond the coverage of surveillance radar, thus requiring the use of procedural control. They also operate below the coverage of VHF communications and VOR/DME, requiring alternate types of systems, several of which are recommended.

Author

**N79-33181#** Federal Aviation Administration, Washington, D. C. Systems Research and Development Service.

**OPERATIONAL EVALUATION OF AN OPTICAL INFRARED AIRBORNE PROXIMITY WARNING INDICATOR (APWI) Final Report**

Ernest Lucier Dec. 1978 38 p  
(AD-A073178; FAA-RD-78-153) Avail: NTIS  
HC A03/MF A01 CSCL 01/3

The results of an operational evaluation conducted between by general aviation pilots on an Airborne Proximity Warning Indicator (APWI) are summarized. The FAA conducted an operational evaluation of the APWI using four systems installed in general aviation aircraft. The evaluation produced results consisting of questionnaires completed by the general aviation pilots who flew the system.

J.M.S.

**N79-33182#** Ambac Industries, Fort Washington, Pa.  
**AIRBORNE DETERMINATION OF GROUND SPEED: A FEASIBILITY STUDY** Final Report, 28 Feb. 1978 - 28 Mar. 1979

Frank Greenwood Feb. 1979 41 p refs  
(Contract DOT-FA78WA-4214)  
(AD-A073193; FAA-RD-79-19) Avail: NTIS  
HC A03/MF A01 CSCL 01/2

To obtain the aircraft speed during instrument landing system approaches, an algorithm was developed which utilizes the glide slope deviation signal and the rate of descent, as determined from the radar or barometric altimeter. The accuracy of these inputs is determined from a study of all appropriate Federal Aviation Administration flight inspection records and from examination of topographic maps of the areas beneath the flights for which records were available. It was found that irregularities in the glide slope, variations in the slope of the terrain, and rapid fluctuations in the barometric pressure associated with wind shear will all induce excessive errors in the value obtained for the ground speed.

Author

**N79-33183#** National Aviation Facilities Experimental Center, Atlantic City, N. J.  
**SIMULATION STUDY OF THE OPERATIONAL CHARACTERISTICS OF A TWO/THREE-DIMENSIONAL MULTIWAYPOINT AREA NAVIGATION (RNAV) SYSTEM** Final Report, Jan. - Aug. 1977

Donald Eldredge, Warren G. Crook, B. Delano DeBaryshe, and William R. Crimbring Aug. 1979 190 p refs  
(AD-A073204; FAA-RD-79-31; FAA-NA-78-46) Avail: NTIS  
HC A09/MF A01 CSCL 01/2

Pilot capability to fly air traffic control offsets and vertical profiles for both two and three-dimensional area navigation (RNAV)

modes both with and without the use of a flight director was evaluated using simulation tests conducted at the National Aviation Facilities Experimental Center. Total system crosstrack error (TSCT) and flight technical error (FTE) were considered. Pilot performance was assessed on horizontal tracking, vertical tracking, and turns. The major findings were: (1) 2 sigma and 2 RMS steady state tracking data for centerline and offset tracking were within + or - 1.5 nautical miles of the course being flown, (2) summary data for centerline turns never exceeded a 2 nautical miles error range; (3) centerline tracking was less variable than offset tracking; (4) the use of 3D RNAV mode to arrive at a specified altitude at a specific location increased pilot workload along the route segment leading to that location, (5) lag times for pilot response to ATC RNAV clearances were found to be a function of the situation complexity; and (6) the calculated RSS statistic proved to be an overconservative estimator of TSCT errors. A.R.H.

**N79-33184#** Federal Aviation Administration, Washington, D. C.  
**THE SELECTION OF GLIDE SLOPE ANTENNA PATTERNS FOR USE IN THE FREQUENCY ASSIGNMENT PROCESS** Final Report

Mark Lopez Jul. 1979 91 p  
(AD-A073176; FAA-RD-79-75) Avail: NTIS  
HC A05/MF A01 CSCL 01/2

Horizontal antenna patterns for glide slope antennas are presented for consideration in the frequency assignment process. Emphasis is placed on the separation required between glide slope frequency assignments. For each antenna type, a particular antenna pattern is recommended.

J.M.S.

**N79-33186#** National Technical Information Service, Springfield, Va.

**MICROWAVE LANDING SYSTEMS. CITATIONS FROM THE NTIS DATA BASE** Progress Report, 1964 - Jun. 1979  
William E. Reed Aug. 1979 187 p Supersedes NTIS/PS-78/0731; NTIS/PS-77/0617; NTIS/PS-76/0555; and NTIS/PS-75/417 2 Vol.  
(NTIS/PS-79/0777/7; NTIS/PS-78/0731; NTIS/PS-77/0617; NTIS/PS-76/0555; NTIS/PS-75/417) Avail: NTIS  
HC \$28.00/MF \$28.00 CSCL 17G

Federally-sponsored research on the planning, development, and operation of aircraft microwave landing systems is presented. Studies include feasibility, systems engineering, equipment, signal propagation, and cost analysis. This updated bibliography contains 181 abstracts, 35 of which are new entries to the previous edition.

GRA

**N79-33187#** National Technical Information Service, Springfield, Va.

**MICROWAVE LANDING SYSTEMS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE** Progress Report, 1970 - Jun. 1979

William E. Reed Aug. 1979 106 p Supersedes NTIS/PS-78/0732; NTIS/PS-77/0618; and NTIS/PS-76/0556 2 Vol.  
(NTIS/PS-79/0778/5; NTIS/PS-78/0732; NTIS/PS-77/0618; NTIS/PS-76/0556) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 17G

The bibliography cites reports from worldwide research on the planning, development, and operation of microwave landing systems, including feasibility, systems engineering, equipment, signal propagation, and cost analysis. This updated bibliography contains 100 abstracts, 11 of which are new entries to the previous edition.

GRA

**N79-33188#** National Technical Information Service, Springfield, Va.

**AIR TRAFFIC CONGESTION AND CAPACITY. A BIBLIOGRAPHY WITH ABSTRACTS** Progress Report, 1964 - May 1979

Guy E. Habercom, Jr. Jun. 1979 178 p Supersedes NTIS/PS-78/0598, NTIS/PS-77/0567, NTIS/PS-76/0495, and NTIS/PS-75/0376

(NTIS/PS-79/0594/6; NTIS/PS-78/0598; NTIS/PS-77/0567; NTIS/PS-76/0495; NTIS/PS-75/0376) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 01E

Present and predicted air traffic density and capacity, both enroute and in airport environments, are analyzed. Terminal area scheduling, runway queueing, and airspace regulation are discussed. This updated bibliography contains 172 abstracts, 13 of which are new entries to the previous edition. GRA

**N79-33189#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**EFFECT OF IMAGE TILT OF A VIRTUAL IMAGE DISPLAY ON SIMULATED TRANSPORT TOUCHDOWN PERFORMANCE**

Russell V. Parrish, William M. Kahlraum, Jr., and George G. Steinmetz Washington Oct. 1979 17 p refs (NASA-TP-1520; L-13087) Avail: NTIS HC A02/MF A01 CSCL 01C

An evaluation of the visual effect of image tilt of a refractive lens display system is presented. The system was used to present a rudimentary computer generated out the window scene to the pilot of a flight simulator during approach, flare, and touchdown. Comparisons are made of sink rate at touchdown and performances for untilted and tilted displays. Sixty four landings with each condition for a total of 128 touchdowns were made by 3 subjects. Performance measures, such as the flare and touchdown footprints, were recorded and analyzed. The visual effect of the image tilt was investigated for a terrain model board scene. A.W.H.

**N79-33190#** Aeronautical Research Labs., Melbourne (Australia). **LOAD SPECTRUM MEASURING EQUIPMENT. PART 2: DETAILS OF MK 2 SYSTEM USED TO ACQUIRE TORQUE LOAD DATA IN SEA KING HELICOPTERS**

K. F. Fraser and U. R. Krieser Sep. 1978 55 p refs (ARL/MECH-ENG-Note-372; AR-001-303) Avail: NTIS HC A04/MF A01

Measuring equipment which uses a set of electromechanical counters to indicate either the integrated time in seconds for which torque loading on a transmission component falls within each of a number of bands or the number of times each of a number of torque-bands is traversed, is described. Separation of the torque level into bands is made possible using a single transducer, an amplifier with zero and gain adjustments for setting the extremes of the torque range of interest, an analog to digital converter and decoder to separate the torque range into bands and counters to totalize the contributions relevant to each band. Author

**N79-33191#** National Aeronautics and Space Administration, Wallops Station, Wallops Island, Va.

**PROCESSING OF ON-BOARD RECORDED DATA FOR QUICK ANALYSIS OF AIRCRAFT PERFORMANCE**

Norman H. Michaud Sep. 1979 326 p (NASA-RP-1043) Avail: NTIS HC A15/MF A01 CSCL 01C

A system of independent computer programs for the processing of digitized pulse code modulated (PCM) and frequency modulated (FM) data is described. Information is stored in a set of random files and accessed to produce both statistical and graphical output. The software system is designed primarily to present these reports within a twenty-four hour period for quick analysis of the helicopter's performance. A.R.H.

**N79-33192#** Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

**A-10 STATIC STRUCTURAL TEST PROGRAM Final Report**

Thomas F. Hughes, Martin D. Richardson, and Frederick E. Husson Feb. 1979 94 p refs (AF Proj. 329A) (AD-A071782; AFFDL-TR-79-3014) Avail: NTIS HC A05/MF A01 CSCL 20/11

The Fairchild Republic Company A-10 aircraft was subjected to a complete static structural test program covering all the critical flight, landing, and ground handling conditions. There were

79 separate test conditions in this test program. Four of these conditions were selected to be run as failing loads tests at the conclusion of the test program. There were no major structural failures of the primary structure. There were some failures and design deficiencies in secondary structure. GRA

**N79-33193#** Indianapolis Center for Advanced Research, Ind. Fluid Dynamics Labs.

**COMPRESSOR RESEARCH FACILITY AERODYNAMICS ANALYSIS Final Technical Report, Oct. 1974 - Jul. 1978**

G. David Huffman Apr. 1979 379 p refs (Contract F33615-75-C-2008; AF Proj. 3066) (AD-A070623; FDL-78-005; AFAPL-TR-79-2021) Avail: NTIS HC A17/MF A01 CSCL 21/5

This report documents a series of aerodynamic studies carried out jointly by AFAPL and ICFAR personnel in support of the design and development of the AF Aero Propulsion Laboratory Compressor Research Facility (CRF). The CRF is a non-return compressor test facility with air extracted from the atmosphere, compressed and then discharged to the atmosphere. In order to reduce compressor power requirements and simulate flight conditions at elevated altitudes, the compressor is mounted in a large tank or test chamber. The tank pressure is regulated with control valves with the compressor itself supplying the exhauster capability. The mass flow rate is measured downstream of the compressor using a series of venturis. The CRF utilizes automated data handling procedures and is capable of simulating some compressor transients. A pilot program utilizing an existing J-85 engine test facility at AFAPL was initiated to explore and develop the measurement technology required in transient compressor testing. GRA

**N79-33194#** Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

**ARMY AIRCRAFT FIRE CONTROL SYSTEMS PERFORMANCE EVALUATION Final Report**

1 Jun. 1979 79 p refs (AD-A070758; TOP-7-1-006) Avail: NTIS HC A05/MF A01 CSCL 19/5

This TOP provides an overview of the testing required for evaluation of the performance or effectiveness of modern Army aircraft weapon systems. A chart of test inputs to an aircraft armament system effectiveness evaluation is provided. Test and analysis procedures for accuracy and dispersion inputs are presented in detail. GRA

**N79-33195#** Textron Bell Helicopter, Fort Worth, Tex.

**FLIGHT TEST EVALUATION OF THE HIGH INERTIA ROTOR SYSTEM Final Report, 21 Sep. 1976 - 1 Feb. 1979**

L. W. Dooley and R. D. Yearly Jun. 1979 119 p refs (Contract DAAJ02-76-C-0064)

(AD-A071648; USARL-TR-79-9) Avail: NTIS HC A06/MF A01 CSCL 01/3

The objectives of this program were to document the reduction in height-velocity restrictions for autorotational landings, the increased transient performance and maneuver capability using modified flight techniques, and the handling qualities of a modified OH-58A helicopter with a High Energy Rotor System (HERS). The rotor incorporated increased chord blades and provision for three different tip weights resulting in Lock number variations of 2.61, 3.14, and 5.43. GRA

**N79-33196#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

**PRELIMINARY AIRWORTHINESS EVALUATION OH-58C HELICOPTER Final Report**

George M. Yamakawa, Robert M. Buckanin, John F. Hagen, and Thomas E. Burch Mar. 1978 80 p refs (AD-A071699; USAAEFA-76-11-1) Avail: NTIS HC A05/MF A01 CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted a Preliminary Airworthiness Evaluation of the OH-58C helicopter from 21 February through 4 March 1978 at Arlington, Texas. Eighteen flights consisting of 14.7 hours of productive flight test time were flown while conducting a limited handling

qualities evaluation of the aircraft. Testing was conducted primarily at maximum gross weight (3200 pounds) and aft center of gravity (fuselage station 112) conditions. The possibility of inadvertent activation of the night vision goggle switch located on the pilot cyclic control grip was identified as a deficiency. Activation of this switch during day flight rendered the warning and caution lights unreadable. The most significant difference in flying qualities between the OH-58C and the OH-58A was pitch-up tendency at cruise airspeed and aft center of gravity, which is a shortcoming. Insufficient left directional control in right sideward flight, excessive yaw oscillations in left sideward flight between 15 and 39 knots true airspeed, and excessive pitch and yaw oscillations in rearward flight are also shortcomings. Eight additional shortcomings were noted. GRA

**N79-33197#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

**LIMITED AIRWORTHINESS AND FLIGHT CHARACTERISTICS EVALUATION MODEL 214A HELICOPTER WITH FIBERGLASS MAIN ROTOR BLADES Final Report, 29 Aug. - 13 Oct. 1978**

Jerry R. Guin, Robert D. Robbins, Gary L. Bender, and Edward E. Bailes May 1979 95 p refs  
(AD-A071721; USAAEFA-77-32) Avail: NTIS  
HC A05/MF A01 CSCL 01/3

Thirty-six test flights for a total of 20.4 productive flight hours were accomplished. Within the scope of this evaluation, the Model 214A helicopter with the fiberglass main rotor blades exhibited slightly improved hover and level flight performance at higher gross weight-altitude combinations. The handling qualities remain essentially unchanged from those exhibited by the Model 214A helicopter with standard rotor blades. The enhancing characteristic noted was the low level-flight vibration levels. The deficiency noted was the inadequate directional control at airspeeds greater than 15 KTAS in right sideward flight at high gross weight, density altitude combinations, which is not attributable to the fiberglass rotor installation. GRA

**N79-33198#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

**PRELIMINARY AIRWORTHINESS EVALUATION AH-1S HELICOPTER INSTALLED WITH ENHANCED COBRA ARMAMENT SYSTEM (AH-1S/ECAS) Final Report, Jul. - Aug. 1978**

Patrick J. Moe, Robert Williams, Raymond B. Smith, and Ralph Woratschek Feb. 1979 138 p refs  
(AD-A071343; USAAEFA-78-03) Avail: NTIS  
HC A07/MF A01 CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted a preliminary airworthiness evaluation of the Enhanced Cobra Armament System (ECAS) with the universal turret subsystem and M-197 20mm gun installed. The purpose of the test was to evaluate the effects of turret installation and weapons firing on the helicopter. Additionally, a limited stability and control evaluation of the helicopter (gun stowed) was conducted. Flight testing was performed at Yuma Proving Grounds, Arizona, and consisted of 27 flight test hours (15 productive). GRA

**N79-33199#** Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.

**SKIN AND SPAR INTERFACE PROGRAM (SASIP) Final Technical Report, 20 Jun. 1975 - 29 Sep. 1978**

Allen Gonsiska and Richard T. Achard May 1979 131 p refs  
(AF Proj. 2401)  
(AD-A071715; AFFDL-TR-79-3054) Avail: NTIS  
HC A07/MF A01 CSCL 01/3

This program had two basic goals. First was the investigation of the effects of fuel pressure (flatwise tension) loads and chordwise (transverse tension) loads on several integral composite skin/spar concepts. The second goal was the development of suitable tooling which could be used to produce these types of structural components. Several concepts were designed, produced, and tested under the required loading conditions. Results indicated that (a) integral composite skin/spar concepts could be manufactured using hard auto-clave tooling or elastomeric tooling and (b) concepts could be designed to carry the required loads, provided

some type of coupling device is used to help distribute the loads from the spar to the skin. GRA

**N79-33201\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**A REVIEW OF SOME HEAD-UP DISPLAY FORMATS**

J. M. Naish (NAS-NRC) Oct. 1979 51 p refs  
(NASA-TP-1499; A-7708: HUD-4) Avail: NTIS  
HC A04/MF A01 CSCL 01D

Two alternate head-up display devices (HUD) were compared for properties relevant to the accurate performance of concurrent tasks in real flight conditions and in various flight modes. The comparisons were made to find the disorientation resistance of the HUDs along with the tracking accuracy, interference resistance, fixation resistance, and error resistance. The use of displacement and flight path information for vertical control is discussed in terms of flight stability. Several combinations of symbols and driving signals are described, including a compensated control law, which were used in simulated flight to deal with wind shear. A.W.H.

**N79-33202#** Dynamics Research Corp., Wilmington, Mass.  
**DIGITAL AVIONICS INFORMATION SYSTEM (DAIS): TRAINING REQUIREMENTS ANALYSIS MODEL (TRAMOD), VOLUME 1 Final Report, Dec. 1977 - May 1978**

Andrew J. Czuchry, Kristy M. Doyle, Jonathan T. Frueh, H. Anthony Baran, and Duncan L. Dieterly Apr. 1979 69 p refs  
(Contract F33615-75-C-5218)  
(AD-A068474; AFHRL-TR-78-58-Vol-1) Avail: NTIS  
HC A04/MF A01 CSCL 05/9

The training requirements analysis model (TRAMOD) described in this report represents an important portion of the larger effort called the Digital Avionics Information System (DAIS) Life Cycle Cost (LCC) Study. TRAMOD is the second of three models that comprise a LCC impact modeling system for use in the early states of system development. As part of the overall modeling system, the training model is an efficient tool for developing training programs on the basis of task, time, and resource criteria. This report explains the approach used in developing this model and its analytic value as a method for determining training requirements. Also, the methodology used to develop the task-related characteristic data necessary for its application to the DAIS are addressed. The model is described by explaining the techniques and algorithms used to accomplish its function. The interactive nature of TRAMOD affords the user great flexibility in structuring its operation while retaining the capability of addressing specific training problems in depth. This report explains the basis for available options. The Users Guide, Volume II, presents these options and illustrates the manner in which user/model interaction is accomplished. GRA

**N79-33203** North Carolina State Univ. at Raleigh.

**AN EXPERIMENTAL STUDY OF THE RESPONSE OF A TURBOMACHINE ROTOR TO A LOW FREQUENCY INLET DISTORTION Ph.D. Thesis**

Larry Warren Hardin 1979 160 p  
Avail: Univ. Microfilms Order No. 7923049

An experiment was conducted to measure the response of an isolated turbomachine rotor to a distortion in inlet axial velocity. A once-per-revolution sinusoidal variation in axial velocity with an amplitude of approximately twenty percent of the average axial velocity was generated by an upstream screen. The response of the rotor was studied using pressure transducers and skin friction gages mounted on one of the rotor blades and a velocity probe at the rotor exit plane as well as with standard stationary frame pneumatic instrumentation. Dissert. Abstr.

**N79-33204\*#** Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

**LAMINATED TURBINE VANE DESIGN AND FABRICATION Final Report, 20 Dec. 1976 - 20 Mar. 1979**

W. G. Hess 19 Oct. 1979 70 p refs  
(Contract NAS3-20587)  
(NASA-CR-159655; FR-11662) Avail: NTIS  
HC A04/MF A01 CSCL 21E

A turbine vane and associated endwalls designed for advanced gas turbine engine conditions are described. The vane design combines the methods of convection cooling and selective areas of full coverage film cooling. The film cooling technique is utilized on the leading edge, pressure side, and endwall regions. The turbine vane involves the fabrication of airfoils from a stack of laminates with cooling passages photoetched on the surface. Cold flow calibration tests, a thermal analysis, and a stress analysis were performed on the turbine vanes. A.W.H.

**N79-33205\*** General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.

**ANALYTICAL EVALUATION OF THE IMPACT OF BROAD SPECIFICATION FUELS ON HIGH BYPASS TURBOFAN ENGINE COMBUSTORS** Final Report

J. R. Taylor Aug. 1979 75 p refs  
(Contract NAS3-20799)

(NASA-CR-159641: R79AEG504) Avail: NTIS  
HC A04/MF A01 CSCL 21E

Six conceptual combustor designs for the CF6-50 high bypass turbofan engine and six conceptual combustor designs for the NASA/GE E3 high bypass turbofan engine were analyzed to provide an assessment of the major problems anticipated in using broad specification fuels in these aircraft engine combustion systems. Each of the conceptual combustor designs, which are representative of both state-of-the-art and advanced state-of-the-art combustion systems, was analyzed to estimate combustor performance, durability, and pollutant emissions when using commercial Jet A aviation fuel and when using experimental referee board specification fuel. Results indicate that lean burning, low emissions double annular combustor concepts can accommodate a wide range of fuel properties without a serious deterioration of performance or durability. However, rich burning, single annular concepts would be less tolerant to a relaxation of fuel properties. As the fuel specifications are relaxed, autoignition delay time becomes much smaller which presents a serious design and development problem for premixing-prevaporizing combustion system concepts. A.R.H.

**N79-33206\*** General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.

**CF6 JET ENGINE PERFORMANCE IMPROVEMENT PROGRAM. SHORT CORE EXHAUST NOZZLE PERFORMANCE IMPROVEMENT CONCEPT**

W. A. Fasching Sep. 1979 113 p refs  
(Contract NAS3-20629)

(NASA-CR-159564) Avail: NTIS HC A06/MF A01 CSCL 21E

The short core exhaust nozzle was evaluated in CF6-50 engine ground tests including performance, acoustic, and endurance tests. The test results verified the performance predictions from scale model tests. The short core exhaust nozzle provides an internal cruise sfc reduction of 0.9 percent without an increase in engine noise. The nozzle hardware successfully completed 1000 flight cycles of endurance testing without any signs of distress. Author

**N79-33207\*** Lockheed-California Co., Burbank. **STUDY OF THE APPLICATION OF HYDROGEN FUEL TO LONG-RANGE SUBSONIC TRANSPORT AIRCRAFT. VOLUME 1: SUMMARY** Final Report

G. D. Brewer, R. E. Morris, R. H. Lange, and J. W. Moore Jan. 1975 56 p refs For vol. 2 see N75-30163

(Contract NAS1-12972)  
(NASA-CR-132558: LR-26752-1) Avail: NTIS  
HC A04/MF A01 CSCL 21E

The feasibility of using liquid hydrogen as fuel in advanced designs of long range, subsonic transport aircraft is assessed. Both passenger and cargo type aircraft are investigated. Comparisons of physical, performance, and economic parameters of the LH<sub>2</sub> fueled designs with conventionally fueled aircraft are presented. Design studies are conducted to determine appropriate characteristics for the hydrogen related systems required on board the aircraft. These studies included consideration of material, structural, and thermodynamic requirements of the

cryogenic fuel tanks and fuel systems with the structural support and thermal protection systems. A.W.H.

**N79-33208\*** IIT Research Inst., Chicago, Ill. **TURBINE ENGINE PARTICULATE EMISSION CHARACTERIZATION** Final Report, 10 Jun. 1978 - 31 Dec. 1979

John D. Stockham, Erdmann H. Luebcke, Donald L. Fenton (New Mexico State Univ., Las Cruces), Ralph H. Johnson (United Airlines, San Francisco), and Paul P. Campbell (United Airlines, San Francisco) Jan. 1979 129 p refs  
(Contract DOT-FA75WA-3123)

(AD-A073198: FAA-RD-79-15) Avail: NTIS  
HC A06/MF A01 CSCL 21/5

Particulate emissions from the TF-30, JT8D, and JT9D aircraft turbine engines were characterized for mass emission rate, particle size distribution, particle shape, and elemental composition as a function of engine type, fuel type, and power setting. Samples were collected from the exhaust plane of the engines with a sampling system developed under the contract. Two fuels were examined, Jet A and Pearl Kerosene. At idle power the TF-30 emitted 3.13 grams of particulate matter per kg of fuel consumed; the JT8D engine averaged 0.79 g/kg; no JT9D engine point was obtained. At takeoff power the TF-30 emitted 6.90 g/kg; the JT8D, 0.59 g/kg; and the JT9D, 0.38 g/kg. Geometric mean particle sizes ranged from 0.043 mm to 0.097 mm with particle size related to power level. Pearl Kerosene generally gave lower emissions and smaller particles than Jet A fuel. No elements were detected and it is assumed the particles are essentially carbon. Particle shape was difficult to quantify but the trend is for particle structure to be more complex or agglomerated at the higher power levels. Author

**N79-33209\*** AiResearch Mfg. Co., Torrance, Calif. **THERMAL-STRUCTURED DESIGN STUDY OF AN AIR-FRAME-INTEGRATED SCRAMJET** Final Report, Jun. 1975 - Dec. 1978

O. A. Buchmann Oct. 1979 38 p refs  
(Contract NAS1-13984)

(NASA-CR-3141: AiResearch-78-15442-1) Avail: NTIS  
HC A03/MF A01 CSCL 21E

Design concepts for the cooled structures assembly for the Langley Scramjet engine, for engine subsystems, and for the aircraft/engine interface were developed and evaluated. Results show that the objectives for the Scramjet engine can be met. A thermal protection system was defined that makes it possible to attain a life of 100 hours and 1000 cycles, which is the specified goal. With stoichiometric combustion, the fuel provides an adequate heat sink for cooling the engine at Mach numbers up to 9 at the minimum fuel flow condition. The mechanical design is feasible for manufacture using conventional materials. For the cooled structures in a six-module engine, the mass per unit capture area is 1328 kg/sq m (259 lb/sq ft). The total mass of a six-module engine assembly including the fuel system is 1577 kg (3477 lb). A.R.H.

**N79-33210\*** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**EFFECTS OF DIFFUSION FACTOR, ASPECT RATIO AND SOLIDITY ON OVERALL PERFORMANCE OF 14 COMPRESSOR MIDDLE STAGES**

Werner R. Britsch, Walter M. Osborn, and Mark R. Laessig Washington Sep. 1979 148 p  
(NASA-TP-1523; E-9943) Avail: NTIS HC A07/MF A01 CSCL 21E

A series of high hub tip radius ratio compressor stages representative of the middle and latter stages of axial flow compressors is discussed. The effects of aspect ratio, diffusion factor, and solidity on rotor and stage performance are determined. Fourteen middle stages are tested to study the effects on performance of varying both diffusion through the rotor and stator blades and blade aspect ratio. The design parameters in the streamline analysis program, the blade geometry program, and the blade coordinate program are presented. A.W.H.

**N79-33211#** Monsanto Research Corp., Dayton, Ohio.  
**RECLAMATION OF SYNTHETIC TURBINE ENGINE OIL MIXTURES** Final Report, 15 Mar. 1976 - 15 Mar. 1978  
Gerald Glasgow and Richard J. Bruns Apr. 1979 179 p refs  
(Contract F33615-76-C-2037; AF Proj. 3048)  
(AD-A071813; MRC-DA-780; AFAPL-TR-78-50) Avail: NTIS HC A09/MF A01 CSCL 11/8

The objective of this program was to develop a technique for reclaiming used synthetic turbine engine oil mixtures and to demonstrate the technical feasibility of the developed reclamation technique by restoring a limited number of used MIL-L-7808 oils to a satisfactory performance level. Reclamation process studies based on approaches utilized by the natural oil and fat refining industry resulted in the development of a reclamation process applicable to synthetic ester turbine engine oils. The components of a reclamation process applicable to a broad range of used MIL 7808G oil mixtures were defined and the technical feasibility established by reclamation and evaluation (via qualification tests) of two batches of used oils. Recommendations for improvement and refinement of the process and approaches to more extensive documentation of its viability were made. GRA

**N79-33213#** Detroit Diesel Allison, Indianapolis, Ind.  
**REGRESSION SIMULATION OF TURBINE ENGINE PERFORMANCE (RSTEP), TASK 1** Final Report, Sep. 1977 - Feb. 1979  
Richard A. Sulko and Robert E. Clark Mar. 1979 62 p  
(Contract F33615-77-C-2071; AF Proj. 3066)  
(AD-A071400; DDA-EDR-9710; AFAPL-TR-79-2013) Avail: NTIS HC A04/MF A01 CSCL 20/5

The results of developing six alternate calculation procedures for parametric turbine engine performance computer programs are presented. The alternate procedures were evaluated separately and then collectively in a baseline parametric engine performance program. The alternate procedures dealt with thermodynamic properties, matrix coefficient prediction, regression of component characteristics, afterburner calculations and regression of the compression process. Analysis of the combined procedures resulted in a cost reduction of approximately 46 percent with average deviations in engine net thrust and fuel flow rate of less than 0.7 percent. GRA

**N79-33214#** Norton Co., Worcester, Mass. Industrial Ceramics Div.  
**INVESTIGATION OF THE USE OF CERAMIC MATERIAL IN AIRCRAFT ENGINE BEARINGS** Final Report, 14 Jun. 1976 - 19 Dec. 1978  
John W. Lucek and Paul E. Cowley (Federal Mogul Corp., Ann Arbor, Mich.) Jun. 1979 57 p refs  
(Contract N00019-76-C-0251)  
(AD-A070631) Avail: NTIS HC A04/MF A01 CSCL 13/9

A program to initiate life factor correlation between hot-pressed silicon nitride rolling elements and M-50 steel hybrid rolling elements has been completed. All materials for component fabrication have been procured and qualified. Retainers and test tooling are complete. Complications in rolling contact fatigue qualification of roller stock, traced to specimen preparation techniques did not allow completion of bearing fabrication. A considerable effort was dedicated to study of the RCF qualification for ceramic materials resulting in development of machining techniques to produce bearing quality silicon nitride surfaces without super-finishing. Static Hertzian indentation of silicon nitride surfaces, fracture energy measurements, and radioactive gas penetrant tracers were found to be potentially valuable evaluation techniques for ceramics in the rolling contact environment. GRA

**N79-33215** California Inst. of Tech., Pasadena.  
**OPTIMAL CONTROLLER DESIGN METHODS FOR LINEAR SYSTEMS WITH UNCERTAIN PARAMETERS-DEVELOPMENT, EVALUATION, AND COMPARISON**  
Ph.D. Thesis

Aharon Pesach Vinkler 1979 96 p  
Avail: Univ. Microfilms Order No. 7919856

The multistep guaranteed cost control method and the minimum discrete expected cost method are discussed. The former is based on the concept of minimizing an upper bound of a cost functional in the face of parameter uncertainty. An algorithm was developed to analyze the effect of parameter uncertainties on closed-loop system stability. The minimum discrete expected cost method is based on the concept of minimizing the expected value of a cost functional over a finite number of points in the range of parameter uncertainty. The design process makes use of statistical information about the uncertain parameters and incorporates in its cost functional whatever effects accompany a large departure in the plant parameters from their nominal values. These two methods together with the guaranteed cost control method, the minimax method, and the uncertainty weighting method, are compared in the context of the design of a fifth-order lateral autopilot for an RPV with uncertain aerodynamic coefficients.

Dissert. Abstr.

**N79-33216\*#** Naval Academy, Annapolis, Md.  
**WIND TUNNEL INVESTIGATION OF THE FREE-WING/FREE TRIMMER CONCEPT** Status Report, Jan. - Oct. 1979  
Doral R. Sandlin Oct. 1979 59 p refs  
(Grant NsG-4020)  
(NASA-CR-162351) Avail: NTIS HC A04/MF A01 CSCL 01C

The conclusions arrived at in this investigation are: (1) the free-wing/free-trimmer configuration is a viable concept, and exhibited both static and dynamic stability for a trimmer pivot at the 10 percent chord position; (2) unless properly controlled, friction in the mounting system and instrumentation can significantly affect the panel response; and (3) for the configurations tested, the control was far too sensitive, giving the full range of wing angle-of-attack for trimmer flap displacements of only a few degrees.

M.M.M.

**N79-33217\*#** Lockheed-California Co., Burbank.  
**ACCELERATED DEVELOPMENT AND FLIGHT EVALUATION OF ACTIVE CONTROLS CONCEPTS FOR SUBSONIC TRANSPORT AIRCRAFT**  
Oct. 1979 62 p refs  
(Contract NAS1-14690)  
(NASA-CR-159148; LR-29111) Avail: NTIS HC A04/MF A01 CSCL 01C

The flight test of an active load alleviation/extended span for the L-1011 wide-body transport aircraft, and piloted simulation work leading to use of active stability augmentation with a small tail and aft center of gravity are reported. The extended span showed the expected cruise drag reduction of 3%. The small tail is expected to reduce cruise drag by another 3%, and eventual use of more aft center of gravity with active stability augmentation will provide further fuel savings. The active load alleviation functions included maneuver load control (MLC) and elastic mode suppression (EMS), using symmetric motions of the outboard ailerons to reduce wing bending loads in maneuvers or long-term up- or down-drafts (MLC), and to damp wing bending motions in turbulence (EMS). A gust load alleviation function using the active horizontal tail to provide airplane pitch damping in turbulence was found unnecessary. The piloted simulation tests evaluated criteria for augmentation-on and augmentation-off flying qualities. of a simple pitch control law was verified at neutral static margin. The simulation tasks established the basis for follow-on construction and flight testing of a small tail with active stability augmentation.

A.R.H.

**N79-33218\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.  
**FIXED-BASE SIMULATION STUDY OF DECOUPLED LONGITUDINAL CONTROLS DURING APPROACH AND LANDING OF A MEDIUM JET TRANSPORT IN THE PRESENCE OF WIND SHEAR**  
G. Kimball Miller, Jr. Oct. 1979 69 p  
(NASA-TP-1519; L-12842) Avail: NTIS HC A04/MF A01 CSCL 01C

The use of decoupled longitudinal controls during the approach and landing of a typical twin-engine jet transport in the presence of wind shear was studied. The simulation included use of a

localizer and flight director to capture and maintain a 3 deg glide slope. The pilot then completed the landing by using visual cues provided below an altitude of 200 m by closed-circuit television and a terrain model. The decoupled controls used constant prefilter and feedback gains to provide steady state decoupling of flight path angle, pitch angle, and forward velocity. The use of the decoupled control system improved pilot performance during the approach and at touchdown in the presence of wind shears. The pilots preferred the decoupled controls and rated the task 1 to 3 increments better on a pilot rating scale, depending on wind conditions, than was the case when conventional controls were used. J.M.S.

**N79-33220\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**ENVIRONMENTAL FOG/RAIN VISUAL DISPLAY SYSTEM FOR AIRCRAFT SIMULATORS Patent Application**

Wendell D. Chase, inventor (to NASA) Filed 29 Jun. 1979 62 p

(NASA-Case-ARC-11158-1; US-Patent-Appl-SN-053566) Avail: NTIS HC A07/MF A01 CSCL 14B

A combination of electronic and mechanical integrated elements which operate together are used to produce realistic environmental conditions that would actually be encountered by a pilot flying an aircraft. The electronic elements of the system include a real time digital computer, a calligraphic color display which simulates landing lights of selective intensity, and a color television camera for producing a moving color display of the airport runway as depicted on a model terrain board. The mechanical simulation elements of the system include an environmental chamber which can produce natural fog, nonhomogeneous fog, rain and fog combined, or rain only. A pilot looking through the aircraft windscreens will look through the fog and/or rain generated in the environmental chamber on to a viewing screen with the simulated color image of the airport runway, and observe a very real simulation of actual conditions of a runway as it would appear through actual fog and/or rain.

NASA

**N79-33222\*** National Aviation Facilities Experimental Center, Atlantic City, N. J.

**EVALUATION OF THE PULSED ACOUSTIC DOPPLER WITH SHEAR SENSING SYSTEM AT DULLES INTERNATIONAL AIRPORT Final Report, Feb. - Dec. 1977**

Peter V. Versage and Augusto M. Ferrara Aug. 1979 31 p (FAA Proj. 154-751-100)

(AD-A073206; FAA-RD-78-158; FAA-NA-79-1) Avail: NTIS HC A03/MF A01 CSCL 01/5

The test and evaluation of the pulsed acoustic Doppler wind shear sensing system (PADWSS) was directed to determine if the system could accurately and continuously sense windspeed and wind direction at 30 meter intervals from 30 to 510 meters above ground level. Three other wind shear sensing systems were used for comparison: (1) instrumented tethered balloon in close proximity, (2) instrumented aircraft flights using flat runs at various altitudes and glide slope approaches, and (3) radar wind shear sensing. It was concluded that the evaluated PADWSS system cannot be utilized on an operational basis. It was adversely affected by environmental conditions (bare trees, snow) and ground windspeeds in excess of 5 meters/second (9.72 knots). M.M.M.

**N79-33263\*** Southwest Research Inst., San Antonio, Tex. **NONDESTRUCTIVE EVALUATION OF FIBER REINFORCED EPOXY COMPOSITES: A STATE-OF-THE-ART SURVEY Final Report, 28 Sep. 1978 - 30 Apr. 1979**

George A. Matzkanin, Gary L. Burkhardt, and Cecil M. Teller Apr. 1979 195 p refs

(Contract DLA900-77-C-3733)

(AD-A071973; SwRI-15-4823-510)

USAFAVRADCOM-TR-79-24) Avail: NTIS HC A09/MF A01 CSCL 11/4

This report contains the essential findings of a comprehensive survey of the state-of-the-art in nondestructive evaluation (NDE) of fiber reinforced epoxy composites with emphasis on the types presently used or planned for use in Army helicopter compo-

nents. Primary consideration is given to the NDE of glass fiber composites because of its extensive use in the fabrication of advanced helicopter rotor blades with secondary consideration given to the NDE of Kevlar, graphite, and boron reinforced epoxy. A computer search of the literature was performed to compile an extensive bibliography of source documents. Pertinent documents were reviewed and NDE results categorized according to NDE methodology and type of composite. For each composite type, tables were developed listing defects and property variations detected by various NDE methods. These tables along with literature references are included in the report. The status of NDE of fiber reinforced epoxy composites with respect to available techniques, ongoing research, and projected future needs is reviewed and summarized.

GRA

**N79-33293\*** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

**AN INVESTIGATION OF FLAME STABILITY IN A COAXIAL COMBUSTOR Ph.D. Thesis**

E. T. Curran Jan. 1979 243 p refs

(AF Proj. 3012)

(AD-A070701: AFIT/AE/DS/79-1) Avail: NTIS HC A11/MF A01 CSCL 21/5

An investigation of the flame stability of a coaxial dump combustor was made. A 6.0 inch diameter combustor was studied, and the inlet diameter was varied from 2.5 inch to 5.0 inch. Tests were carried out using pre-mixed ethylene/air and JP-4/air. The inlet temperature levels were generally in the range 1000-1250 R; the corresponding pressure was varied between approximately 10 and 40 psia. Inlet Mach numbers were typically in the range 0.2 to 0.9. The flame stability data were not collapsed by a conventional correlation. A new correlation parameter was derived by modelling the annular recirculation zone as an adiabatic stirred reactor using a one-step chemical reaction: this parameter gave successful correlations. The dominant variable in flame stability was the inlet temperature. The effect of velocity on the lean limit was small. Some tests were performed with additional fuel injection directly into the recirculation zone, which yielded an estimate of the air mass flow fraction entrained into the recirculation zone. Finally, tests were performed using a transparent combustor; it was observed that the combustion process was an oscillatory phenomenon. A review of the literature concerning the flame stability and aerodynamics of coaxial combustors is presented.

GRA

**N79-33336\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**JET FUEL THERMAL STABILITY**

William F. Taylor, ed. (Exxon Research and Engineering Co., Linden, N. J.) 1979 158 p Workshop held at Cleveland, 1-2 Nov. 1978

(NASA-TM-79231) Avail: NTIS HC A08/MF A01 CSCL 21D

Various aspects of the thermal stability problem associated with the use of broadened-specification and nonpetroleum-derived turbine fuels are addressed. The state of the art is reviewed and the status of the research being conducted at various laboratories is presented. Discussions among representatives from universities, refineries, engine and airframe manufacturers, airlines, the Government, and others are presented along with conclusions and both broad and specific recommendations for future stability research and development. It is concluded that significant additional effort is required to cope with the fuel stability problems which will be associated with the potentially poorer quality fuels of the future such as broadened specification petroleum fuels or fuels produced from synthetic sources. A.R.H.

**N79-33337\*** Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

**PHYSICAL AND CHEMICAL PROPERTIES OF JP-4 FUEL FOR 1978 Final Technical Report, Jan. - Dec. 1978**

Blaine A. Heitkamp Apr. 1979 93 p

(AF Proj. 3048)

**N79-33338**

(AD-A070525; AFAPL-TR-79-2040) Avail: NTIS  
HC A05/MF A01 CSCL 21/4

Random samples of 651 fuel inspection reports on JP-4 fuel have been analyzed for the calendar year 1978. Determination of average properties and frequency distribution of these properties has been undertaken. Properties selected were twenty-three different parameters which coincide with JP-4 fuel specifications (MIL-T-5624K). Through comparison of previous reports, specifically 1975, it can be noted that no major fluctuations have occurred. In compiling the data, all reports were given equal weight regardless of what quantity of fuel was represented. Also, this year the only method used for testing fuel thermal stability was the JFTOT (ASTM Method D 3241) Fuel Coker.

GRA

**N79-33338#** Monsanto Research Corp., Dayton, Ohio.  
**ANALYSIS OF AIRCRAFT FUELS AND RELATED MATERIALS** Final Report, 1 Feb. 1976 - 1 Jun. 1978  
F. N. Hodgson and J. D. Tobias Wright-Patterson AFB, Ohio  
AFAPL Mar. 1979 289 p refs  
(Contract F33615-76-C-2014; AF Proj. 3048)  
(AD-A070739; MRC-DA-865; AFAPL-TR-79-2016) Avail: NTIS HC A13/MF A01 CSCL 21/4

The physical properties of a series of JP-9 fuels, whose compositions covered the entire range allowed by the fuel specification, were determined. Included in the study are density, viscosity, surface tension, vapor pressure, specific heat, thermal conductivity, dielectric constant, air/nitrogen/water solubility, heat of combustion and freeze point. A proposed gas chromatographic method for the analysis of JP-9 fuel has been validated and results are reported. A survey of methods for hydrocarbon type analysis in fuels was conducted. Specific NMR approaches to this kind of analysis were applied to jet fuels and are presented. Analytical data are reported to determine the effect on combustion of modifying various fuels. A number of special studies which were conducted to aid in the solution of Air Force operational problems were conducted and are reported.

GRA

**N79-33339#** Monsanto Research Corp., Dayton, Ohio.  
**ANALYSIS OF THE EMISSIONS FROM STORAGE TANKS DURING JP-4 FUEL TRANSFER OPERATIONS. PHASE 3: COLD WEATHER CONDITIONS** Final Report  
W. R. Feirheller 14 Jun. 1979 53 p  
(Contract F41608-78-C-1240)  
(AD-A070818) Avail: NTIS HC A04/MF A01 CSCL 21/4

The objective of this program was to determine the amount of JP-4 vapor emitted to the atmosphere during fuel transfer operations. Emissions from 50,000-gallon underground operating tanks were measured and analyzed by a total hydrocarbon analyzer containing a flame ionization detector.

GRA

**N79-33347#** National Technical Information Service, Springfield, Va.

**HYDROGEN USE AS A FUEL. CITATIONS FROM THE NTIS DATA BASE** Progress Report, 1964 - Jun. 1979  
Audrey S. Hundemann Aug. 1979 191 p Supersedes NTIS/PS-78/0635; NTIS/PS-77/0522; NTIS/PS-76/0458 (NTIS/PS-79/0779/3; NTIS/PS-78/0635; NTIS/PS-77/0522; NTIS/PS-76/0458) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 21D

Federally-funded research studies pertaining to the technical feasibility of using hydrogen as a fuel for vehicular transportation, electric power generation, and both subsonic and supersonic aircraft are discussed. One hundred and eighty six abstracts, 24 of which are new entries to the previous edition are reported.

GRA

**N79-33376#** National Aviation Facilities Experimental Center, Atlantic City, N. J.  
**AN EVALUATION OF CERTAIN SELECTED MODIFICATIONS TO THE NATIONAL AIRSPACE SYSTEM BIMODAL TRACKING ALGORITHM**

Robert E. Lefferts Apr. 1979 41 p refs Continuation of work reported in FAA-NA-79-15

(AD-A072084; FAA-NA-79-16; ANA-220; ANA-1) Avail: NTIS HC A03/MF A01 CSCL 17/9

Various modifications of the standard bimodal tracking algorithm were considered, including a comparison of fixed versus dynamic search areas, circular versus noncircular search areas, the introduction of a one-scan delay before use of the large search area smoothing constants, and an evaluation of the influence of the search area design probability on the performance of the tracking algorithm. For a straight-line trajectory, the velocity errors observed using the fixed search area design were approximately three times larger than those theoretically obtainable using an alpha-beta tracking algorithm. The use of a dynamic search area with one-scan delay gave a considerable improvement in the straight-line performance of the tracking algorithm, while at the same time small reductions were observed in the peak transient errors for maneuvering targets. Since the performance of the tracking algorithm is highly dependent on the size of the search area, search area parameters should be site dependent to allow equivalent performance from all radar sites.

K.L.

**N79-33383#** Sandia Corp., Livermore, Calif.  
**ROADRUNNER: A NOVEL RADAR GUIDANCE CONCEPT**  
James R. Kelsey 1979 7 p refs Presented at the 2d Echelon Armor Interdiction Symp., Chicago, 1 May 1979  
(Contract EY-76-C-04-0789)  
(SAND-79-0412C; Conf-790536) Avail: NTIS HC A02/MF A01

An exploratory development program aimed at demonstrating a novel radar navigation/guidance scheme which enables a small unmanned aircraft (drone) to follow roads is presented. Since vehicles on the road can be easily detected, this aircraft could be used as either a strike vehicle itself or as a reconnaissance adjunct to another strike system. The guidance scheme involves onboard radar measurements of the backscatter response of the terrain beneath the aircraft. The differences in reflectivity between road and roadside surfaces are processed by a small onboard computer to generate guidance commands to keep the vehicle over the road. Preliminary system definition includes a 17 GHz radar aboard a subsonic, propeller-driven unmanned aircraft. The drone could be either ground or air launched, and would be expendable. Payload capabilities of 50 to 100 kg are envisioned, with an operational range of 50 to 100 km.

DOE

**N79-33453#** Grumman Aerospace Corp., Bethpage, N.Y.  
Research Dept.  
**DEVELOPMENT OF CALORIMETRIC FATIGUE GAUGE** Final Report  
John M. Papazian, Richard Delasi, and Philip N. Adler May 1979 40 p refs  
(Contract N00019-76-C-0651)  
(AD-A070844; RE-572) Avail: NTIS HC A03/MF A01 CSCL 20/11

A research effort to devise a new fatigue gauge for aircraft is described in this report. Differential scanning calorimetry was used to detect microstructural changes resulting from strain-controlled fatigue exposure of aluminum alloy 7050. The calorimetric signature of the microstructure was determined for samples that had been cycled to failure at strains of -0.3, -0.6, and -1.5%. Some samples were also fatigued to failure with a small positive or negative mean strain offset, and others were cycled to 30% or 70% of their expected life at -1.5%. Thermodynamic and kinetic analyses of the calorimetric results revealed a pronounced effect of fatigue at -1.5% strain on the reaction enthalpy and reaction kinetics of the GP zone dissolution peak. The reaction enthalpy decreased systematically as the number of cycles increased. No effects of fatigue on the calorimetric results were observed in the samples that were fatigued at -0.3 and -0.6%. Based upon these results the characteristics of a potential 'calorimetric fatigue gauge' were outlined. Such a gauge would only be sensitive to low cycle 'plastic' fatigue and would produce a cumulative damage parameter, thus indicating the percentage of lifetime expended.

GRA

**N79-33477#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**NASA GEAR RESEARCH AND ITS PROBABLE EFFECT ON ROTORCRAFT TRANSMISSION DESIGN**

Erwin V. Zaretsky, Dennis P. Townsend, and John J. Coy 1979 19 p refs Presented at the Meeting on Helicopter Propulsion Systems, Williamsburg, Va., 6-8 Nov. 1979; sponsored by Am. Helicopter Soc. (NASA-TM-79292; E-236) Avail: NTIS HC A02/MF A01 CSCL 131

The results of the NASA gear research is reviewed as well as those programs which are presently being undertaken. Research programs studying pitting fatigue, gear steels and processing, life prediction methods, gear design and dynamics, elastohydrodynamic lubrication, lubrication methods and gear noise are presented. The impact of advanced gear research technology on rotorcraft transmission design is discussed. M.M.M.

**N79-33480#** Northrop Corp., Hawthorne, Calif. Aircraft Group.

**ADVANCED WELDBONDING PROCESS ESTABLISHMENT FOR ALUMINUM Final Report, Nov. 1976 - Oct. 1978**

T. R. Croucher Feb. 1979 361 p refs (Contract F33615-76-C-5412) (AD-A071016; NOR-78-185; AFML-TR-79-4006) Avail: NTIS HC A16/MF A01 CSCL 01/3

This program was conducted to establish the manufacturing parameters necessary to produce structural aircraft fuselage panels by the aluminum weldbonding process. These panels were representative of adhesive bonded panels currently being employed on the USAF/Fairchild Republic A-10. A design, feasibility and trade-off study was conducted by Fairchild, and a representative test panel was designed for comparing the structural performance of weldbond vs. adhesive bonded panels on a 1:1 basis. Northrop Corporation established the manufacturing procedures and process specifications which were used to manufacture the weldbonded panels. Fatigue and damage tolerance tests were conducted to evaluate the effect of different manufacturing variables on fatigue life. These tests showed that weldbonded structures would compare favorably with adhesive bonded structures, and would be significantly superior to riveted structures in low-load transfer fatigue applications. GRA

**N79-33483#** Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

**STRUCTURAL LIFE PREDICTION AND ANALYSIS TECHNOLOGY Final Report, Oct. 1975 - Nov. 1978**

T. A. Cruse and T. G. Meyer Dec. 1978 119 p refs (Contract F33615-75-C-2063; AF Proj. 3066) (AD-A070935; PWA-FR-10896; AFAPL-TR-78-106) Avail: NTIS HC A06/MF A01 CSCL 20/11

An improved low cycle fatigue (LCF) life exhaustion method has been developed for gas turbine engine disks subjected to complex mission history loading. The method has been incorporated into a computer program for LCF life exhaustion prediction as a function of component, material, mission history, and mission ordering. Principal advances in LCF life modeling include a simple strain range-mean stress correlation model, a predictive model for the effects of strain hardened surface layers due to machining and the effects of dwell (creep) due to elevated temperature exposure time, a fracture mechanics-based nonlinear, cumulative damage model, a statistical basis for minimum part life prediction, and full-scale component verification. Simplified procedures for nonlinear stress (strain) analysis of notches were developed and calibrated with finite element results. Recommendations for further research emphasize the need for improved constitutive models of cyclic creep/plasticity, a better definition of the effects of various machining operations on material work hardening, as well as residual stresses. Calibrated models for small flaw fracture mechanics would benefit the definition of the cumulative damage algorithm. Finally, the need to control process variability in order to improve part life is emphasized. GRA

**N79-33486#** Battelle Pacific Northwest Labs., Richland, Wash. **DEVELOP THE APPLICATION OF A DIGITAL MEMORY ACOUSTIC EMISSION SYSTEM TO AIRCRAFT FLAW MONITORING**

P. H. Hutton and J. R. Skorpik Dec. 1978 74 p refs (Contract EY-76-C-06-1830; ARPA Order 3476) (PNL-2873) Avail: NTIS HC A04/MF A01

The use of the acoustic emission (AE) technique to provide a definitive continuous monitor of fatigue crack growth in a critical aircraft structural member was evaluated. A unique AE monitoring system was fabricated and laboratory tested. It utilizes a source isolation feature to distinguish AE originating from an identified area of interest. Two parameters of AE information are recorded on one solid state digital memory for later retrieval and analysis. Installation was made in RAAF Macchi 326 aircraft A7-201 during a major maintenance overhaul. The system is monitoring AE from fatigue cracks in a fastener hole in the tension member of the wing structure center section continuously during flight. Four test flights to evaluate system performance and make necessary adjustments were conducted. DOE

**N79-33498#** Technische Hogeschool, Delft (Netherlands). **PREDICTION METHODS FOR FATIGUE CRACK GROWTH IN AIRCRAFT MATERIAL**

J. Schijve Jun. 1979 44 p refs Presented at the 12th Natl. Symp. on Fracture Mech., 21-23 May, St. Louis; sponsored by ASTM

(LR-282; ICAF-1100) Avail: NTIS HC A44/MF A01

A survey is given of relevant knowledge on fatigue crack growth and qualitative and quantitative understanding of predictions. Aspects of cycle-by-cycle predictions and characteristic K prediction methods are discussed. Prediction problems are covered including: (1) crack growth under flight-simulation loading with crack closure measurements; (2) predictions for flight-simulation loading based on a constant crack opening stress level; and (3) crack growth under pure random loading with different s sub rms-values, two irregularities, and two crest factors. Random load tests carried out to explore the usefulness of K sub rms are discussed. J.M.S.

**N79-33504#** McDonnell Aircraft Co., St. Louis, Mo. **ENVIRONMENT LOAD INTERACTION EFFECTS ON CRACK GROWTH Final Report, Jul. 1976 - Aug. 1978**

H. D. Dill and C. R. Saff Nov. 1978 224 p refs (Contract F33615-76-C-3133) (AD-A071660; AFFDL-TR-78-137) Avail: NTIS HC A10/MF A01 CSCL 11/6

The objective of this program was to systematically investigate chemical environment-load interaction effects on crack propagation. The program was focused by developing a set of design guidelines and criteria for a durability and damage tolerance control plan for landing gear. Current life prediction capability was assessed by comparison of prediction and test. A field survey was conducted to catalog the size, type, and locations of flaws in landing gear components. A crack growth prediction capability developed through analysis and test accounts for environment and load interaction effects. Materials studied are HP-9Ni-4Co-.30 and 300M steels, and 7075-T6 and 7049-T73 aluminums. A flight-by-flight test stress history was developed for a landing gear component, and crack growth predictions prepared. Subsequently, spectrum tests were performed. A Durability/Damage Tolerance Control Plan for landing gear is outlined. GRA

**N79-33505#** Ohio State Univ. Research Foundation, Columbus. **LARGE AMPLITUDE RESPONSE OF COMPLEX STRUCTURES DUE TO HIGH INTENSITY NOISE Final Report, May - Aug. 1978**

Chuh Mei Wright-Patterson AFB, Ohio AFFDL Apr. 1979 42 p refs

(Contract F44620-76-C-0052) (AD-A071401; AFFDL-TR-79-3028) Avail: NTIS HC A03/MF A01 CSCL 20/11

A problem of interest to the Air Force is the design of acoustically sound aircraft structural components. This is because sonic fatigue failures have resulted in unacceptable maintenance and inspection burdens associated with the operation of the aircraft. In some instances, sonic fatigue failures have resulted in major redesign efforts of structural components. Currently, the sonic fatigue design methods are based upon a combination of experimental and analytical techniques. The analytical methods are based on the linear or small deflection theory (Sonic Fatigue Design Guide for Military Aircraft, AFFDL-TR-74-112, for example). But, on the contrary, the test structural panels respond nonlinearly with large deflections at high intensity acoustic pressure levels. This large amplitude geometrical nonlinearity is the major factor that causes disagreement between the computed and the measured random responses. To improve the analytical design methods, large deflection or nonlinear structure theory must be employed in the analysis. This report presents a review of existing analytical and numerical methods on random excitation on nonlinear multi-degree-of-freedom systems, and an evaluation of these methods based on some realistic considerations from the point of view of their application to complex panel configurations of aircraft structure. GRA

N79-33650# National Technical Information Service, Springfield, Va.

**AIRCRAFT AIR POLLUTION, VOLUME 3. A BIBLIOGRAPHY WITH ABSTRACTS** Progress Report, 1977 - Jun. 1979

Diane M. Cavagnaro Jul. 1979 150 p Supersedes NTIS/PS-78/0623; NTIS/PS-77/0570; NTIS/PS-76/0529; and NTIS/PS-75/491

(NTIS/PS-79/0645/6; NTIS/PS-78/0623; NTIS/PS-77/0570; NTIS/PS-76/0529; NTIS/PS-75/491) Avail: NTIS HC \$28.00/MF \$28.00 CSCL 04A

Citations include pollution control and statement, emissions data and emission factors, stratospheric pollution, effects the supersonic transport traffic have on the environment, and pollutant concentrations and movement around airports and flight corridors. One hundred and forty four abstracts, 54 of which are new entries to the previous edition are reported. GRA

N79-33739# RAMCOR, Inc., Vienna, Va.

**A REPORT ON ATMOSPHERIC OBSTRUCTIONS TO VISIBILITY. VOLUME 2: RESULTS OF LITERATURE SEARCH** Final Report

Victor J. Lujetic 10 Mar. 1979 80 p refs  
(Contract DAAK70-78-C-0109)

(AD-A071742; ETL-0170-Vol-2; RC168-001-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 04/2

The aims and objectives of this report were to collect and assimilate information and synthesize data on the effects of atmospheric obstructions to visibility. A large part of the total study effort involved an extensive literature search and compilation of a reference and abstract bibliography related to atmospheric effects on visibility. This Volume II includes both the extensive bibliography and abstracts of selected publications related to atmospheric obstructions to visibility and related topics. The information contained in this volume was oriented to the non-specialist. GRA

N79-33759# National Center for Atmospheric Research, Boulder, Colo. Convective Storms Div.

**CASE STUDIES ON CONVECTIVE STORMS. CASE STUDY 1, 22 JUNE 1976: FIRST ECHO CASE**

Daniel W. Breed Dec. 1978 60 p refs  
(Grant NSF ATM-77-23757)  
(PB-295753/8; NCAR/TN-132-STR) Avail: NTIS HC A04/MF A01 CSCL 04B

A sailplane and a 306D Queen Air made a coordinated study of a well developed storm from about 1420 to 1505. The sailplane, penetrating the storm at 5.5 - 9.0 km MSL, encountered two discrete cells with updraft maxima of 15 and 24 m/sec and liquid water contents exceeding 3(g/m cubed).

The maximum precipitation concentration data suggest that the precipitation process was well developed during the sailplane penetration of the two cells, which took place 15-35 minutes past the initial formation of the -5 dBZ reflectivity level. The Queen Air sampled conditions below cloud base which was measured at 3860 m. Precipitation was present, and little evidence of strong updrafts or storm inflow was detected in the area investigated by 306D. GRA

N79-33759# National Center for Atmospheric Research, Boulder, Colo. Convective Storms Div.

**CASE STUDIES ON CONVECTIVE STORMS. CASE STUDY 1, 22 JUNE 1976: FIRST ECHO CASE**

Daniel W. Breed Dec. 1978 70 p refs  
(Grant NSF ATM-77-23757)  
(PB-295754/8; NCAR/TN-130-STR) Avail: NTIS HC A04/MF A01 CSCL 04B

The sailplane penetrated a growing turret on the west side of a developing echo system prior to the time of the radar 'first echo' at the sailplane's altitude. During the 7 minute in-cloud period, the sailplane encountered strong updrafts (maximum 22 m/sec) and increasing ice particle concentrations with time. Radar support was insufficient in providing a total reflectivity history about the sailplane's cloud penetration. The maximum reflectivity encountered by the sailplane was 15-20 dBZ(e). Particle camera data indicated that precipitation-sized particles were exclusively ice; no liquid drops greater than cloud droplet size were detected. GRA

N79-33901# National Oceanic and Atmospheric Administration, Miami, Fla. Research Facilities Center.

**RESEARCH AIRCRAFT MEASUREMENT SYSTEM (RAMS) GRAPHIC SYSTEM USER GUIDE**

W. J. Brown Sep. 1978 32 p refs  
(PB-296343/7; NOAA-TM-ERL-RFC-4; NOAA-79043003)  
Avail: NTIS HC A03/MF A01 CSCL 09B

The WP3-D aircraft data system is described. This system is used to analyze and display atmospheric and oceanic data collected by the aircraft. Its operation and its uses are explained. GRA

N79-33968# Lockheed-California Co., Burbank.

**ANOPP VALIDATION STUDY: LOCKHEED L-1011**

Larry Godby Hampton, Va. NASA 25 Oct. 1979 139 p

(Contract NAS1-15651)

(NASA-CR-159138; LR-29177) Avail: NTIS HC A07/MF A01 CSCL 20A

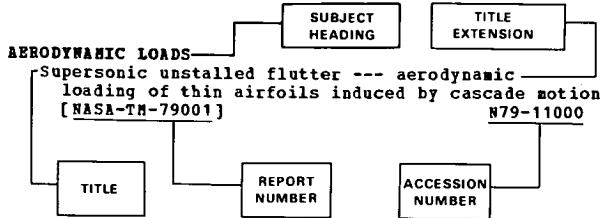
The aircraft noise prediction program (ANOPP) was used to predict the far-field noise characteristics of an L-1011 aircraft equipped with RB.211-524B engines. Actual flight noise was compared with noise predicted for the same operating and weather conditions. Correlation of predicted and measured results was very good in the aft quadrant of radiated noise. Predicted noise levels were significantly different from measured values in the forward quadrant because fan noise was predicted high. Since the major noise sources were fan and core, corrections are supplied to adjust ANOPP fan and core noise components so that the total predicted noise matches the measured L-1011 noise levels. A.R.H.

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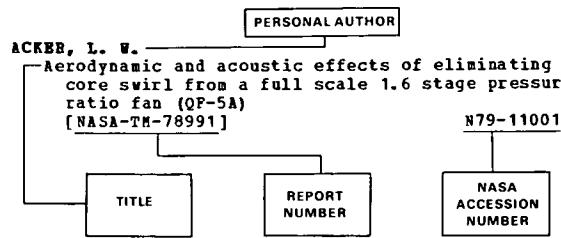
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